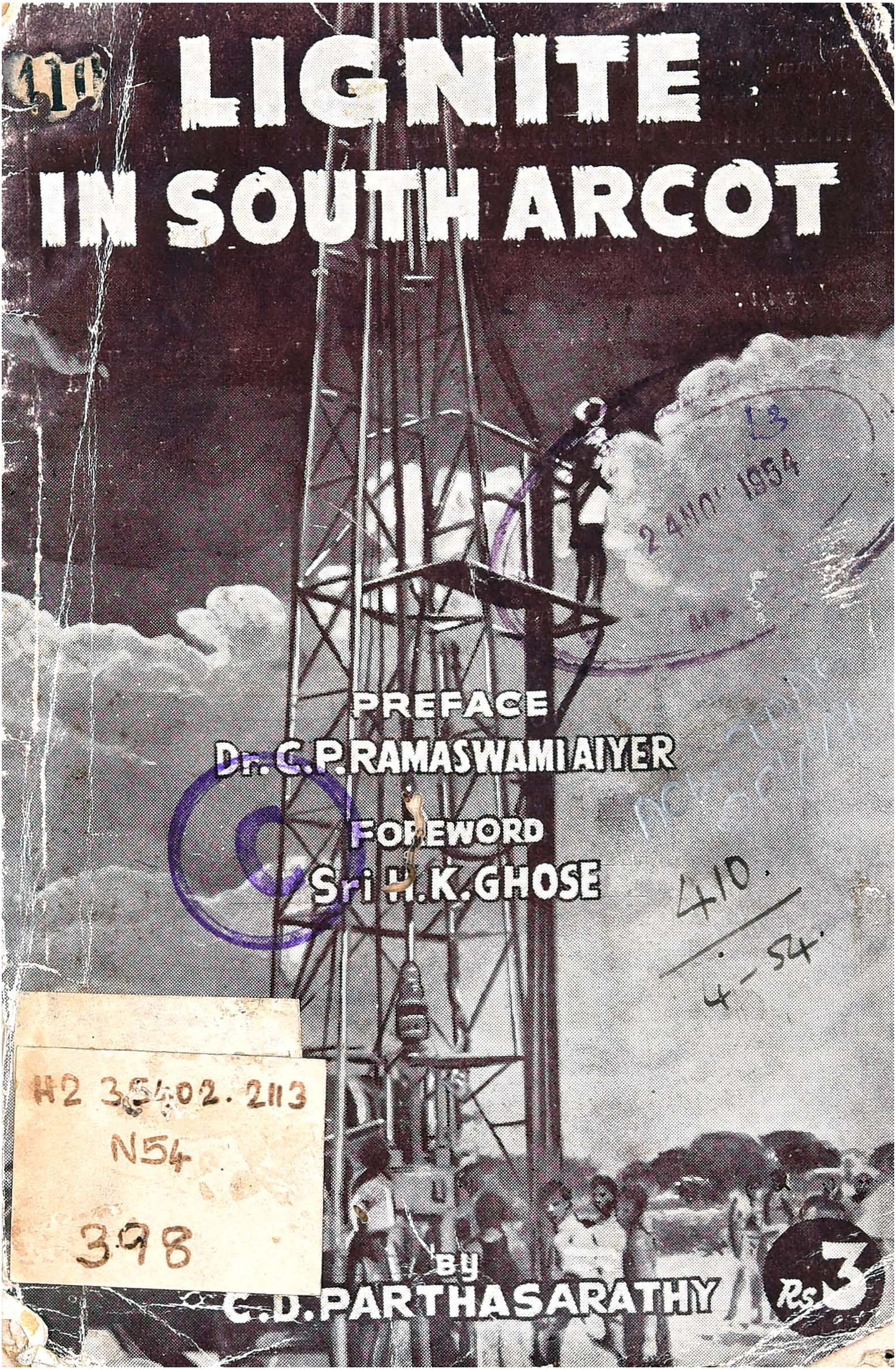
LIGNITE IN SOUTH ARCOT



PREFACE
Dr. C. P. RAMASWAMI AIYER

FOREWORD
Sri H. K. GHOSE

BY
C. D. PARTHASARATHY

Rs 3

24 NOV 1954
410.
4-54.
H2 35402.2113
N54
398

Telegram : "MIDCOLIM"

MERCANTILE & INDUSTRIAL DEVELOPMENT Co., Ltd.,

(House for Lubrication Equipments)

P. B. No. 1509

27/28, **ARMENIAN STREET, MADRAS-1.**

Dealers in :

Wayne AIR COMPRESSORS — ½ H. P. to 10 H. P. Suitable for Petrol Filling Stations, Garages and Service Stations.

Wayne HYDRAULIC LIFTS — Car and Truck lifts from 8,000 lbs., to 20,000 lbs. in different sizes and descriptions.

Alemite ALEMITE LUBRICATION EQUIPMENT Such as greasing Outfits Oil Dispensers Oil Sprayers etc., etc.

Eco AIR TOWERS of various types and designs for inflation of tyres. (Car washers)

Specialists in :

Petroleum Industry requirements such as Bulk Installation Pumps (WAYNE), Couplings (KAMLOCK), Loading Assemblies (O. P. W.) Petrol Dispensing Pumps (WAYNE)
Etc. Etc. Etc.

Suppliers of :

Lubrication Equipments to major oil companies and to various projects in India.

For further information contact near Office

Messrs Mercantile & Industrial Development Co., Ltd.

Vohra House 25/1, Ajmere Gate Scheme, **NEW DELHI**
H. O. Post Bag No. 1050 **BOMBAY**
Punjab House, P-39, Princep Street, **CALCUTTA**

LIGNITE
IN
SOUTH ARCOT

By

C. D. PARTHASARATHY

Preface By

Dr. C. P. RAMASWAMI AIYER

Vice Chancellor, Banares University

Foreword By

H. K. GHOSE, MIME., MMGI.

Officer-in-charge, Lignite Mining, Neiveli.

Published By

The South Arcot Journalists' Association

CUDDALORE N. T.

Copyright]

1954 [Price Rs. 3/-

Printed at
RATHNAM PRESS, MADRAS-1.

TAMIL NADU ARCHIVES LIBRARY
ACC. No.
398
EGMORE, MADRAS-600 008

ILLUSTRATIONS

Dr. C. P. Ramaswami Aiyer

Mr. H. K. Ghose

Silicified tree remains embedded

Coaly layer of undecomposed leaves

First Pit

Artesian Aquifers

Lignite Cores

Samples of Lignite and Clays

Briquettes made in Germany

Fire Bricks

Quarry

Lignite Mined

Potteries

Men getting into Pit

Lignite conveyance

CONTENTS

		Page
Preface — Dr. C. P. Ramaswami Aiyer	...	1
Acknowledgment	...	6
Publishers' Note	...	8
Foreword — Mr. H. K. Ghose	...	9
Introduction	...	10
New find of Black Gold — Lignite	...	15
History of the Investigation	...	21
Artesian Aquifers	...	32
Tests on Lignite	...	44
Uses and Utilisation of Lignite	...	49
Overburden Clays	...	60
Mining	...	65
Fuel Problems of the South	...	72
Mineral Map of the South and Industrial Possibilities	...	79
The Possibilities of Private Enterprise	...	86
The Use of Lignite in High Pressure Industrial Boilers	...	92
Manufacture of Pig Iron from Salem Iron Ore with South Arcot Lignite	...	100
Labour	...	126
Economics of South Arcot Lignite	...	128

Dr. C. P. RAMASWAMI AIYER

PREFACE

Mr. C. D. Parthasarathy has produced a very comprehensive and detailed account of the Lignite deposits of the South Arcot District, and their potentialities. His brochure has been published through the South Arcot Journalists' Association who deserve our thanks for their public spiritedness and who, having studied at first hand the conditions of lignite mining, have kept themselves au fait with subsequent developments.

Throughout this volume, tributes are paid to Sri. Hiran Kumar Ghose, the pioneer of this project but for whom and whose scientific aptitude and resourcefulness, the project could not have resulted in success. Great credit is also due to Mr. Paul Reber Eyrich of the United States Bureau of Mines whose encouragement and help have been of great assistance in the exploitation of these valuable deposits.

Lignite has been termed black or brown gold and may prove in the long run to be more valuable for the industrial regeneration of South India than the auriferous deposits of Kolar. From the beginning of the project, Sri. H. K. Ghose was the Engineer in charge of the mines and he is in the process of transforming the small village of Neiveli as one of the power centres of the South. Various experts, American and German, have been consulted in the past and hopeful prospects were held out but special credit is due to Sri. H. K. Ghose for having surmounted initial difficulties and made an unequivocal success of the scheme. Many of us who have endeavoured in the past to help in the industriali-

sation of the country have been feeling that South India and especially the Tamil Nad is handicapped by a deficiency which was too facilely taken for granted in two of the most valuable appurtenances of heavy industry, coal and iron. Although it has been known for centuries that rich iron ore deposits existed in and near Salem as well as in the Anamalais and although the existence of bauxite and of kaolin was also suspected and indeed has been verified in Travancore, nevertheless, the most anxious search has not revealed the possibility of coal south of Hyderabad. It is therefore, a matter of supreme satisfaction, that recent excavations and researches have revealed the presence of a vast lignite deposit extending over nearly one hundred square miles of territory in the South Arcot District.

It is well known that lignite belongs to the coal group. Geologically, it is immature coal and is composed of disintegrated forest vegetation which has, for millions of years, been subjected to the action of slides and drifts in the bed of the original lagoon area adjoining the Bay of Bengal. Geologists have declared that lignite is coal in the second stage of its formation, the stages being (1) Peat, (2) Lignite, (3) Steam coal and (4) Anthracite. All these have been formed by the decomposition of vegetable matter under shallow water. Lignite is known to occur in various parts of India and especially in Cutch in the north and in Varkali in Travancore; but systematic exploration has never been made. Many countries that possess lignite deposits like Australia and especially Germany have made good use of it for production of power; and in fact lignite has been one of the main stays of Germany's industrial and economic progress. It has been stated that lignite provides the cheapest

fuel but the difficulty has always been that of economic transport. One of the richest fields of lignite in the world has now been discovered in the South Arcot District round Neiveli, not far from Vridhachalam and Chidambaram. This lignite bed is between 18 and 80 feet in thickness and occurs only below 150 feet. It has been computed that even if 10,000 tons are mined every day, the deposits will last for 2000 years. Laboratory tests have disclosed that this lignite has low moisture and ash and sulphur content and that the calorific value is very high even when compared with Bengal coal.

It is curious that as early as 1828, a Collector of Tanjore discovered lignite while digging a well. One hundred years elapsed before Messrs. Binny & Co., put down a few bore-holes and discovered lignite; but one of the remarkable features of South Arcot is that there is an immense amount of underground water which gives rise to artesian springs situated at great depths. The two great requisites of South India-water and fuel-are so situate that the difficulty of getting at lignite is enhanced by the presence of artesian springs whose flow has to be checked in order to reach the lignite beds. Here again, although it has been known for centuries that artesian wells can be sunk in this area, no systematic utilisation of the available water has taken place and people have been either complacent or miserable over droughts and famine with good supplies of water below their feet. It is only since 1947 that any work has been done in the direction of finding eilher water or fuel. These efforts were started on the basis of manual labour and in 1948 when the first pumps were tried, water was found to be rushing up and it was got rid of owing to the diligence and engineering skill of Sri. H. K. Ghose, and finally after a number of bore-holes were dug, a cross-

section of the area was obtained and at one point lignite up to a thickness of 90 feet was touched. The occurrence of artesian wells is also proved over an area of 100 square miles in the region of the Vellar and Manimuktha rivers. There is a horizon of pressure-water above the lignite and then a lower layer of the lignite. It is thus clear that there are water and lignite resources available in the South Arcot District both of which should be fully exploited by the utilisation of the most modern types of pumping, excavating and mining machinery. This pamphlet contains an account of tests made on the South Arcot District lignite which are most satisfactory from the point of future exploitation.

An account is also given of the bye-products which might be utilised for the production of what is called Monton wax and plastics. As a result of German experiment it has been shown that coal plastic like bakalite and carbolic oil can be manufactured from lignite whose special untility is in blast furnaces. Lignite can be used as domestic fuel, as fuel for industrial boilers and for blast furnaces and also in the production of water gas which is a safe and efficient city illuminant. It has been pointed out in this book that at present one and a half million tons of coal are being imported from North India and that much of this importation can be avoided if lignite exploitation is satisfactorily conducted. In the result our hydro-electric installations and thermal stations based on lignite may remedy all our deficiencies. The Salem iron ore is in proximity to these lignite fields and bauxite is not too far away and a plentiful supply of fuel will enable the development of iron and aluminium industries in the South. What is now needed is the speedy introduction of high-class mining machinery so that lignite may be won on a large scale,

The project was inaugurated in March 1953 and is progressing with excavating machinery lent by the Central Government. It is suggested that if arrangements are made for mining a quantity of a million tons a year with the aid of large-size excavators and conveyors, an immediate and big spurt in the industrial development is assured. Such machinery is all the more necessary because a suitable labour corps is not easily available in this district which is mainly a land of peasant proprietors and agriculturists.

A perusal of this brochure makes one optimistic with reference to the industrial and manufacturing possibilities of South India in the near future; and as a means of popular enlightenment and of appraisal of our resources, this hand-book should serve as a most useful vademecum.

The Grove
Teynampet
Madras

C P Ramaswami Aiyar

ACKNOWLEDGMENT

I have taken upon myself a task of magnitude in writing this story of Lignite Mining in South Arcot, in a manner so as to enable the large numbers, to understand all about this project. This project in years to come, should fill every oven and furnace, besides the coffers of the State. This is a matter concerning all and particularly those in Tamil Nad.

I am grateful to my friend Sri Hiran Kumar Ghose, who afforded me ample opportunities to study the project even from the outset.

Dr C. P. Ramaswami Aiyer is the head of the seat of learning in Annamalainagar and these precious fields lie adjacent to and adjoining his seat. In the midst of his heavy work, he has been kind enough to find the time to read the book and write the Preface. I am grateful to him for the great encouragement he had given me and for his good wishes.

The South Arcot Journalists' Association and particularly its energetic Secretary, Sri S. R. Srinivasa Tatachariar, are to be thanked for undertaking this publication. The members of the Association continue to do their best for the success of this project.

I am thankful to Mr. Paul Reber Eyrich of the U. S. Bureau of Mines who in his unostentatious way is doing a great deal for the project. He was useful to me in many ways in writing this book.

My thanks are due to the Editor of "The Hindu" for allowing me to reproduce in this book my articles 'Artesian Aquifers' and 'Fuel Problems' which appeared in their columns. I am thankful to the Editor of the "Times of India" for permission to reproduce one of my articles 'New Find of Black Gold' which appeared in their columns. Some of the photographs appearing in this book are taken by the Government of Madras and are acknowledged with gratitude.

Many have been asking me whether the scheme would be a success. In reply, I can do no better than quote the top men engaged in this work. "If the project is not worked out, we cannot be human beings, we cannot call ourselves Engineers."

Science has so much advanced that in Germany a marshy tract of land is dried up with the help of electricity to enable mining. We are also reading of the possibilities of mining with the help of cosmic rays, discording men and machineries now in use. All those may be far fetched. It is however certain that the Lignite mine is going to be opened shortly to every one's advantage.

A new era of prosperity and fortune is in the offing. The outcome of this project is keenly looked forward to. May we have prosperity is the sincere wish and devout prayer of

C. D. PARTHASARATHY.

PUBLISHERS' NOTE

The South Arcot Journalists' Association, composed of the working journalists of the District of South Arcot is affiliated to the Southern India Journalists' Federation.

The Association, besides sending out news of importance, interests itself in many activities of public interest. Many are the notable achievements of the Association.

About six years ago in 1947, the first prospecting of Lignite Mining was undertaken. Since then the Association is showing more than passing interest in this project At one time the scheme looked almost like being abandoned, owing to the magnitude of the problem and the handicaps of working the same. The public had grown apprehensive at the delay in taking out bulk samples and on the large amounts expended on initial work. The members of the Association were given ample opportunities to study first hand conditions of mining, with the result, it became possible for the Association to keep a continuous stream of accurate and regular reports on the working of the project. With the Press responding admirably, the project caught the public eye and public interest was stimulated and kept alive.

The project today is an accomplished fact. The industrially starved South is already buzzing with activity. The project holds a key position in the future planning of the country in general and the South in particular. All-round prosperity is assured.

The Association rightly felt that the public should share full knowledge and information of the project. A collection of the reports sent out by members of the Association and an extensive study by one of its members, Mr. C. D. Parthasarathy, has enabled the bringing out of this book. Actuated by motives of service to the public, we have undertaken the publication of this. If this should serve the purpose it is intended to, we shall feel, we have more than achieved the objective.

S. R. SRINIVASA TATACHARI.
Secretary, The South Arcot Journalists' Association, Cuddalore N. T.

FOREWORD

I am glad to learn that Mr. C. D. Parthasarathy is bringing out a brochure on Lignite and the South Arcot Journalists' Association, Cuddalore, are publishing the same.

The project is of great importance to India as a whole and South India in particular. I can visualise a new era of prosperity with the development of the lignite deposits.

Many are the possibilities to which I look forward with hope and prayer.

Development of this project has been the dream of my life and I would like to see this accomplished and the dream fulfilled.

Difficulties have come in the way but the sympathy and encouragements I received from my friends and well wishers have borne me through.

It is a matter of great satisfaction that a large section of the public has shown an interest in the Project. The Lignite is, so to say, worth in Gold to South India and a brochure on Lignite which tells the common man the story of this newly found Black Gold-" LIGNITE "-is an imperative need of the hour. I am glad that it has been possible for the Association to draw up and publish such a useful piece of information.

My sincere wishes and devout prayers will remain on this brochure. I wish and pray that the brochure enlightens the public and creates an abiding interest and enthusiasm in them which will help in forwarding the cause of the accomplishment of the Project.

H. K. GHOSE.

H. K. GHOSE

Introduction

Sri Hiran Kumar Ghose M.I.M.E., M.M.G.I., Engineer in charge of Lignite mining, Government of Madras, is in charge of the project from the start.

About hundred years ago, Jyothi Shri Ramalingaswamigal, the Tamil Saint foresung that Vadalur adjacent to and adjoining the lignite mining area, a tiny village of one of the tens of thousands, that go to make the State, would one day grow into Cuddalore, that is, it would become important as a town. As though to fulfill those prophetic words, Sri Ghose came to south all the way from his native Bengal. He was deputed to prospect the mines in July 1947. Little would have people thought that he was taking upon himself a task of very great magnitude. Mining then was considered a simple and straight-forward affair.

With no more than a few crowbars, pick axes and shovels, he had to enter into this vast venture and he did so with a gusto. Single-handed, wholly and solely, as his lot turned out to be, he had his wits pitted against nature at its fury, in an uneven combat against great odds.

This very quiet mining village of Neiveli, almost desolate until very recently, now coming to be known as the mining village, promises to buzz with tremendous life and vie with the largest of industrial centres in India. From Salem to Cuddalore Port, it promises to be one vast stretch of mining field and steel roadway.

Little did one realise that the mining of this Lignite may turn out as difficult as it did. The special problems facing were posed to experts like Messrs. Corbett, Coal Commissioner; J. W. Wittaker, Fuel Research Director; Robert S. Sanford of the U S Bureau of Mines and a host of other experts including top ranking German engineers with experience of coal mining. Although it is true Sri Ghose met with plenty of encouragement from most sources, it is also true that a section started losing faith gradually and whispers went round that the scheme may not be worth while.

If only Sri Ghose had packed and gone, as he should have normally done, there would be no further story to tell of Neiveli now or ever. In this age of miracles when atom is split, a matter like combating artesian aquifers, to take out lignite, did not and could not dissuade him from his mission. With faith, he hung on to this and in his very first attempt, while he was on the eve of taking out a bulk sample, he met with a grave accident, when the artesian aquifers underneath, burst open, to flood away the pit and his endeavours.

Conditions obtaining were very peculiar and unique the like of which had not been experienced ever before in any engineering enterprise, so much so that, there was nothing to learn from outside. Inspite of this, the services of a team of foreign experts were availed of. As though to honour their visit and to assure that an Indian engineer does not lag very far behind, he extracted a bulk sample in his next attempt.

Mining is a huge and gigantic financial commitment. It is estimated that about 100 crores of rupees may perhaps be the investment necessary for exploiting the lignite in full. The State's finances are slender and notwithstanding this, an annual grant of about 15 lakhs of rupees were made during the first three years of work, most of which had gone into capital outlay.

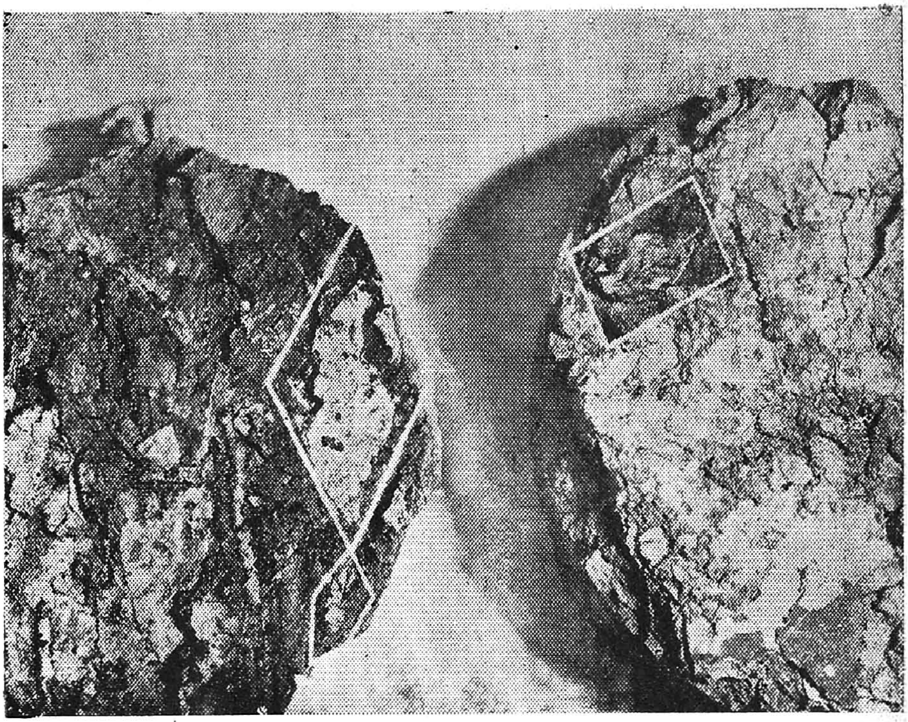
A pilot scheme had become a necessity. Inspite of the very critical financial position of the State, a sum of rupees 70 lakhs was set apart for this purpose, a very generous gesture indeed, and this is a token grant of the State for the confidence it has in this project. The lion's share of this is going into the capital outlay account. The Union Government have thrown the doors of their 'disposals' open to enable the State to pick and choose anything wanted. As there are no prospects of getting from abroad immediately suitable machineries and equipment, and the right type of machineries needed, can only be known after the working of the pilot scheme, best use of the available dump is made to improvise machineries and equipment.

Under President's Point Four Programme, technical aid is made available from America through Mr. Paul Reber Eyrich. The greatest tribute to the Indian engineering skill is paid by this high official of the U. S. Bureau of Mines by his working hand in glove with our men, not in the colossal manner in which his country is known to work such enterprises, but in the simple Indian

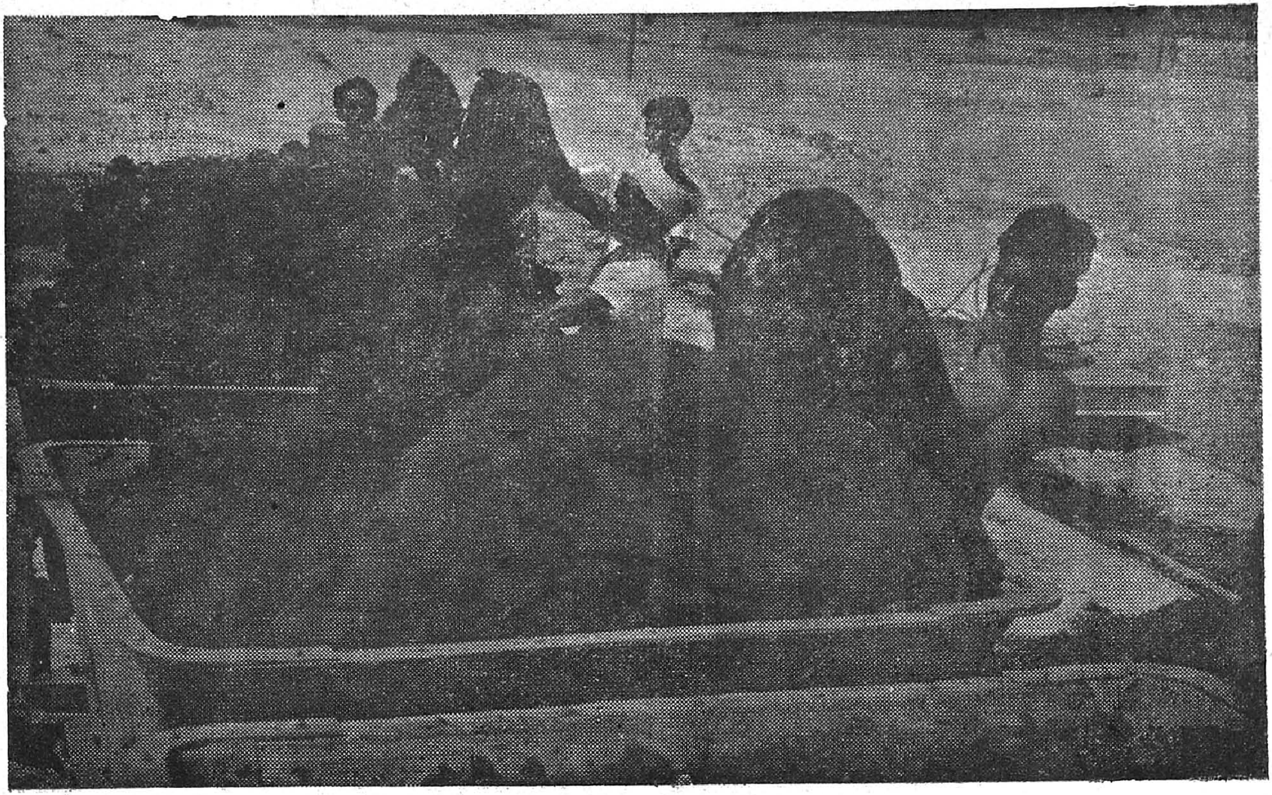
way, not in the capacity of an expert, but as a fellow worker.

After the working of the pilot scheme, lignite is to be worked in full by regular mining. Every one now agrees that this can be done.

Here then is all the very best to the project.



LIGNITE CORES



LIGNITE MINED

GETTING INTO PIT

GETTING INTO PIT

New Find of Black Gold-Lignite

Lignite belongs to the coal group. As it is little brown in colour, it is also called brown coal in some places. When in the formation of lignite underground, owing to geological reasons, the coalification gets arrested, on this account, it is called immature coal.

Volcanic activity and the pouring out of the lavas of the old volcanic epoch continue through out the tertiary age all over the world. South India does not seem to have been subjected to any volcanic activity from the time of the Deccan traps. Further, South India, where the oldest land mass of the world is found, does not also seem to have been subjected to earth movement from early times, as no indication of faulting in this area, is noted. There must have been, it is believed, movements due to sliding adjustments, in the still unconsolidated soft water bearing strata, causing folding of rivers. Lignite bed is drift materials. Large forests which grew on unstable slopes with its growing vegetation must have slid back into the lagoons of the coastal tracts of India by a process of slides and drifts.

Lignite is coal in the second stage of its formation. The stages are *(1) peat (2) lignite (3) steam cōal and bituminous coal and (4) anthracite.*

Peat is formed by the decomposition of vegetable matter (trees, plants etc.) under shallow water in gradually sinking basin. This peat when covered up with great thickness of clay sand etc. in the course of

time is converted into lignite which in turn is converted into coal as the basin sinks and receives further sediments of clay, sand etc. The transformation from peat to coal takes millions of years.

Lignite is found all the world over, associated with dispositions of tertiary age. Even in India it occurs in many parts. In Palana, in Bikanir, Rajasthan State, lignite mines are being worked out. Lignite is known to occur in Cutch States, Guzerat and in the United States of Travancore and Cochin near Varkully. Near Cannanore it is known to be embedded under the town. Beypore in Malabar and near about Bahur in Pondicherry territory, lignite is known to occur near about the surface. These remain to be explored.

Australia has made very good use of lignite in her thermal stations for production of power and as domestic and industrial fuel. Germany with her natural deficiencies, is making good use of lignite and the advancement made by her in meeting the requirements of her oil, iron and coal is something interesting. Lignite is the main stay of Germany's industrial and political power since the 18th century. U S has large deposits and in view of the availability of other fuels in abundance, lignite remains not used to the full extent. In American industry as well, lignite has become an important asset. A significant geographical shift in the American industry may be in the making, according to the Ag. Secretary of the Interior Mr. Richard D.Searless. Lignite, low grade 'young coal,' provides cheapest fuel

for power but cannot be transported economically. Such industries as Alcoa, U S Steel, and Republic Steel are therefore going to the deposits with new processing and manufacturing plants (New Digest Winter 1951). Some other European countries also have lignite.

The richest and largest of fields is struck in South Arcot District, Madras State. Neiveli is a little village lying 11 miles to the east of the town Vridachalam. It is about 20 miles southwest of Cuddalore and 120 miles from the City of Madras. It lies on the branch railway line between Cuddalore and Vridachalam. The western boundary of the field is about 18 miles from the Bay of Bengal.

An area of about 6 miles in width and 17 miles in length lying in a northeast-south west direction between parallels 79 dg. 24' and 79 dg. 33' and 11 dg. 24' and 11 dg. 37' an area of about 100 sq. miles is roughly the hitherto prospected area. The area may stretch further south and needs investigation. Lignite bed is found to be between 13ft. and 80 ft. in thickness and at no place crops up on the surface, the nearest to the surface being 150 ft. The dip is irregular, the seam is lenticular and wavy in character. The deepest point at which lignite is touched is 344 ft. A maximum thickness of 89.9 ft. is met with. At an average, taking out ten thousand tons of lignite per day, the sources, it is believed, may last for a period of 2000 years.

The field is bounded on the north by Gadilam river and in the south by Manimukta river. On the

east, the tertiaries dip under aluvium and sand dunes of east coast.

The deposit seems to have accumalated in the depression in the cretacious which overlie the crystallines in this area. Above the cretacious lie an undetermined thickness of pebble bed which extends from Pondicherry in the north to Vridachalam in the west. This is crossed on the north both by the Ponniar and Gadilam rivers. The pebbles vary in size. The matrix is of ferrigenous sand stone. The tertiary deposits are mainly of fresh water origion. Lignite occurs in between clays and sand stones. It is erratic in formation with no fixed roof. Thickness varies to a very great extent even within short distances. The fossils are not yet examined in detail and therefore the age cannot be determined exactly. It is safe to presume, it is micene in age.

The northern edge of the lignite field forms an undulating ridge running east and west from Cuddalore, known as Mount Copper. The ridge is continuous from Pondicherry and raises sharply from a few miles to the west of Cuddalore. The general lie over the lignite field is a gentle south easterly slope. The area to the north of Cuddalore-Vridachalam road is the continuation of the strip of high ground running across the district from Pondicherry via Mount Copper to Vridachalam. This is mostly covered by latteric rocks and partly by pebbles. The highest point on this ridge which lies to the north-west end of the field is about 300 ft. MSL.

Latterites and latteric rocks generally extend to within about 25 ft. of the surface. Occasionally haemalite pieces are also found scattered or in thin layers.

Liminatic boulders are generally confined to within 100 ft. of the surface scattered in clay beds. Some of these kidney shaped are found to measure 8/10 inches in length and 3 to 5 inches in diameter.

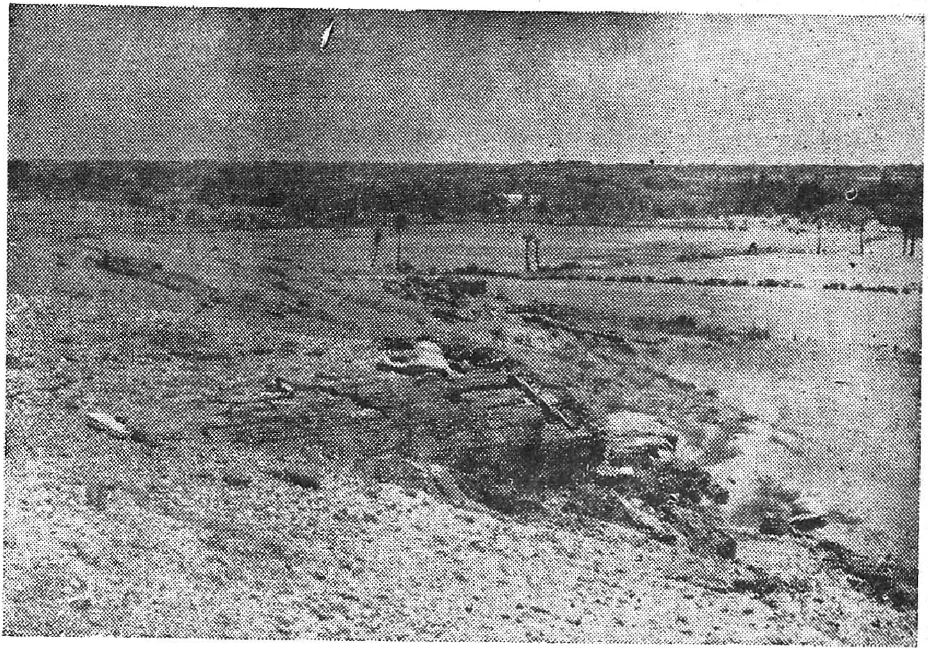
Lignite bed at different localities have exhibited the following textures. (1) The peaty variety is soft clayey which washes away very easily while boring, leaving no cores to obtain. (2) The woody variety is of two kinds. One is of fibrous variety and the other with a charcoal appearance. The woody variety is seen to contain coniferous tree stumps together with half decayed leaves, spores and seed vessels. (3) The brown coal variety is harder than the peaty variety, fine grained, compact and varies in colour between chocolate brown and dark brown. (4) The fourth variety exhibits a coaly structure and is hard and black breaking with a conchoidal fracture.

The marcasite appears in various forms and in various horizons. The texture varies from compact to coarse grain and contains different proportions of sand in them. The marcasite deposit is neither uniform nor continuous in its occurrence and hence its economic value can be discountananced at present.

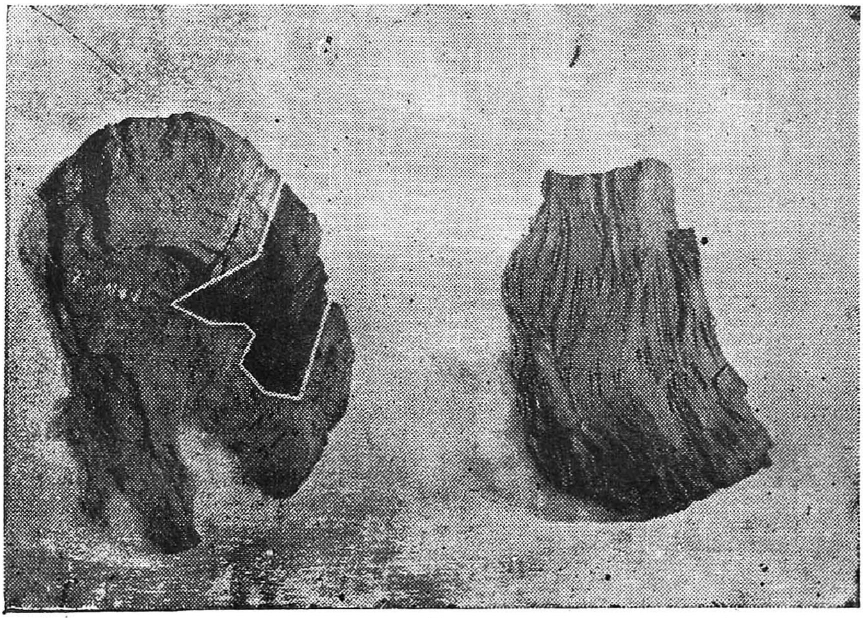
The sand stones are generally soft and of an arcosic nature. They go by the name of Cuddalore sand stones.

In some places the sand stones also contain silicified remains of ancient trees. The clays are mostly soft in nature and are often found intercollated with sandy beds and contain varying percentages of sand, making it difficult sometimes to distinguish between clayey sand stones and sandy clay. The colour of the clays also vary considerably being pure white, pink, buff, rose, violet, iron oxide strained, cement grey and mottled varieties. While some of the white clays exhibit an oily structure the grey clay gives an oily smell too.

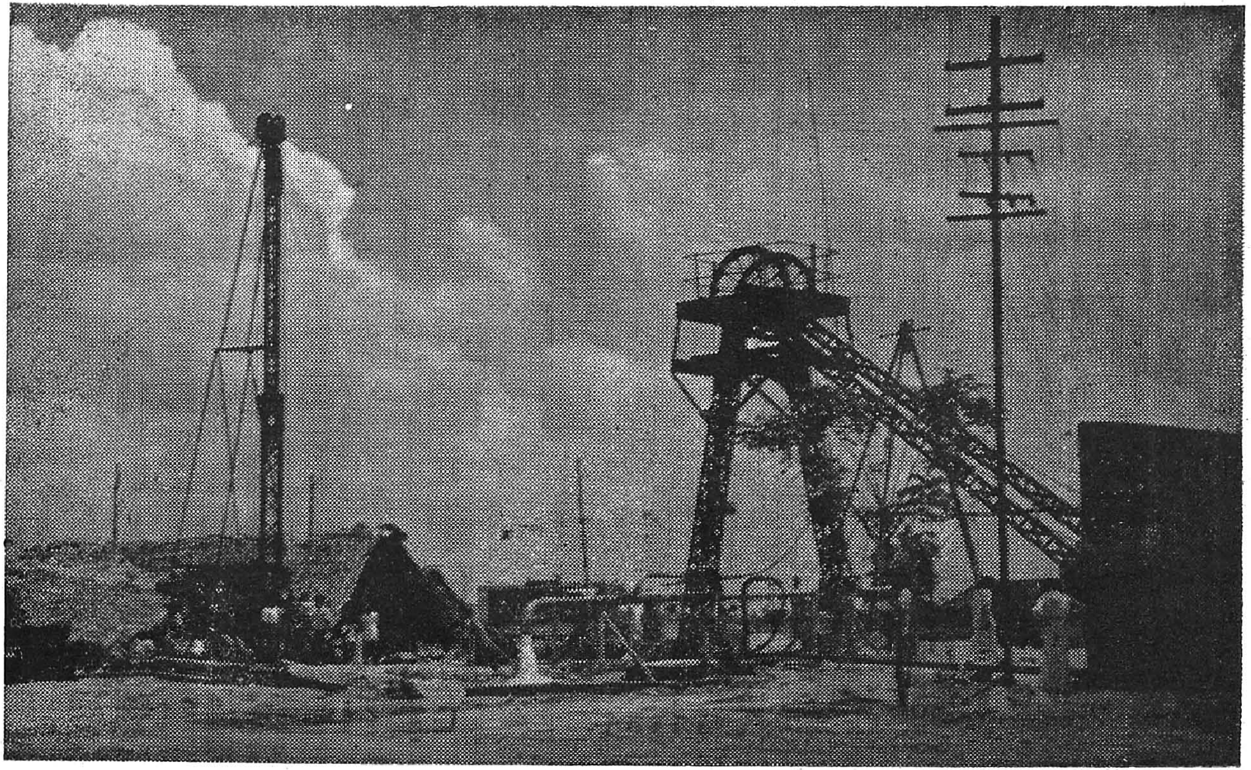
The lignite on being tested in various laboratories has yielded results and the four most important factors that have come to light are (1) that the moisture content is fairly low for this class of fuels; (2) that the ash content is generally low; (3) that the sulphur content is also low; (4) that the calorific value is fairly high comparing with grade I coal of Bengal. Lignite compares in quality with those of other countries as well.



SILICIFIED TREE REMAINS EMBEDDED



COALY LAYER OF UNDECOMPOSED LEAVES



FIRST PIT SUNK

History of the Investigation

In South India so early as 1828, lignite seems to have been struck. One Mr. Nelson, a sub collector of Tanjore reported that while digging a well in Cadarumbum lands about 20 miles from Port Calimore, lignite was struck at a depth of 17 ft. The possibilities in this area remain unexplored to this day.

Official note of the existence of lignite in this area was taken under these circumstances. One Mr. Srinivasa Iyer, a lawyer, while digging a well in his lands situated in Karuvetti village in Chidambaram taluk found thrown out a chocolate brown stuff which continued to burn in air when lighted. As this borehole happened to be made under the supervision of the Industries department, the party was advised to send the sample to the Chemical Examiner, Government of Madras, who described this as fuel similar in properties to that of coal and this again set in motion a series of boring operations by the departmental staff and the conclusions drawn were that lignite occurs in this area.

The first prospecting operation by core boring seems to have been undertaken by Messrs. Binny & Company Ltd., Madras, in 1941 by putting down a few bore holes near about Aziz Nagar, a penal settlement, with core boring drill. But on their encountering pressure water and sand in the holes, further prospecting was abandoned by them.

Though the occurrence of lignite in this area was known for a number of years, no attention was paid to this, till demanded by the exigencies of circumstances, which came about by transport bottleneck during World War II, rendering movement of coal from north to south extremely difficult. In the year 1942, the Government of Madras asked the Geological Survey of India to carry out prospecting of these lignite fields.

Between the years 1943 and 1947, the possibilities were explored by the department by putting down 33 boreholes, mostly to the north of Cuddalore-Vridachallam road. About 53 sq. miles were covered, in which 23 sq. miles were proved to contain lignite between 149 and 253 ft. below, with thickness varying from 105 to 51 ft. They suggested the quarrying operations could be carried out economically in this area which they thought would be free from artesian waters and before commencing quarrying they suggested a trial pit being sunk in this area and advised the Government of Madras to approach the Central Government for help in technical personnel and machinery, who in turn towards the end of 1946 asked the Chief Mining Engineer, Railway Board, to arrange for necessary help. Sri Hiran Kumar Ghose, the then Asst. Regional Coal Controller (Production) Bengal and Bihar, was deputed by the Coal Commissioner to take up the operation of the sinking of the pit to the lignite bed.

The boring operations carried on by the Geological Survey were studied. Near about the places explored

by them it was found the coal to overburden ratio was unfavourable and it was considered that underground mining with solid stowing of the goaf would be more economical and feasible. It was then known that high pressure artesian aquifers existed below the lignite and since the first layer of water was expected to be under the last layer of lignite, a good portion of the lignite was expected to be won by underground mining, using the intervening aquicludes as a barrier against the pressure of water below. The method inview was, advancing long wall of a middle slice of the lignite, with solid stowing of the goaf. It was thought probable that sufficient lignite could be mined cheaply and the bottom artesian aquifer kept under control, if a sufficient thickness was left in the floor, to prevent the heaving of the floor due to the artesian pressure and the long wall advanced was to be quite rapidly followed by pneumatic stowing. The explored area was intended to be only sufficient to allow efficient working of the scheme, thus allowing very little time for the artesian aquifer to exert pressure on any exposed area. It was further proposed that even this exposed area should be protected against pressure by proper timbering and lagging with G.I. sheets both on the floor and the roof, the main roadways proceeding as concrete tunnels through the lignite. It was thought probable that sufficient lignite could be taken out by the above method to make the process economical, particularly in the context of the local demand, supply and price problems.

On a decision therefore taken about the sinking of a large diameter pit (18 ft) by the Government of Madras, at a spot about 600 ft. to the north of Neiveli station, round about 1947, the work on further mining was left to the sole and absolute authority of Sri Ghose.

As no machinery, equipment or stores required for pit sinking operations were available at the initial stages the sinking was started from scratch by manual labour, using crow bars, shovels, pick axes etc. A tripod, for hanging a pulley block, was mas made out of poles and an one inch diameter coir rope passed over the block, served to raise and lower the debris as well as men. The make of water, which was small in the initial stages, was baled out in iron buckets.

Mr. Ghose was in the look out for a more suitable place and suggested another spot, about 300 ft. to the north of the original pit, as there was a large workable area, already proved around the site, and it was also situated conveniently close to the railway, with all the advantages for carrying equipment etc., and latter for putting a railway siding. As about 22 ft. of lignite was proved at a depth of 172 ft. and no special difficulties regarding artesian waters were anticipated, and keeping inview the possibility of an open cast mining round about the area, the second pit, 10 ft. in diameter, was ordered to be sunk at this spot, and work on the first pit was temporarily suspended after reaching about 30 ft.

With growing depth, sinking by manual labour became more and more difficult. Mechanical devices were contrived and manufactured locally from a cable reel drum, used for coiling electric cables, for lessening the arduous nature of the work. The arrangement was something like a Capstain winch, usually used in ships.

The barrel of the drum 3 ft. in diameter was strengthened with iron sheet. A 8 ft, long 3×3 inches sq. bar with rounded ends was passed through a square hole in the iron plates fitted in the flanged ends of the drum which served as an axle for rotating the drum on its axis.

The drum was placed on one of its flanged ends on a prepared platform. The bottom end of the square bar with rounded end, working in a spindled type bearing block was fixed on the platform, and the top end of the square bars also with rounded end being passed through a journal bearing, was fixed to a 10×5 RSJ placed horizontally on brick pillars. Four projecting wooden handles were fixed on to the top flange of the drum, for rotating the drum by human labour. A 5/8 flexible steel wire rope was wound on the barrel of this drum and the free end of this rope was passed on to the pit over a pulley, suspended from RSJ (fixed over brick pillars built alongside the pit shaft), for handling of debris.

This arrangement gave some relief but still the work was slow, arduous and tedious. By this method

another 40 ft. was sunk and with the 50 ft. originally sunk, a depth of 90 ft. was reached.

At this stage a 30 HP electric haulage, a 25 ft. two legged lattice head gear and a 11 KV/550 transformer of 200 KVA capacity, were received from the State Railway collieries. The head gear and haulage were installed in this pit. The transformer was placed on a frame at the HT Electricity supply sub-station.

By the middle of May 1948 electric power supply at 22 KV was switched on to the transformers 11 KV 550V and 11 KV-400V and the haulage and pumps started functioning and the sinking operation was speeded up. A flat topped trolly running on meter gauge lines conveyed the loaded buckets of debris. Fresh air into the pit was let in by a small dupliex pump by means of compressed air delivered from a 105 cfm sullivan air compressor, driven by power in the exhaust from the pump, serving the cool and fresh air into the pit. This 105 ft. deep was sunk and the make of water was comparitively small hitherto.

As the strata turned soft and watery parting easily along ill defined cleats, from the first, the precaution taken, more on intution, of lining the pit with cement brick work, the work considered extravagant, proved very useful in saving the pit from utter collapse and total loss of machineries, equipments etc. The method employed was to follow up sinking of the pit with brick work after every 6 or 7 ft. with cement concrete over wide reinforced cement concrete base rings, forming so

to say, a solid suspended cage or casing for the shaft side from the top.

As the pit was walled up in short lengths no serious difficulty was experienced except once at 100 ft and again at 150 ft. 162 ft. was thus reached. Two small 2×2 inch girdle stone centrifugal pumps connected in series and working at intreval of 10 to 15 minutes were considered adequate to deal with water, although during the latter stages, water rose from 200 gph to 600 gph.

An advanced borehole from the floor was put downwards with the help of boring rods about 1 inch square, and 5 and 10 ft. long, with a chistle end to one of these. On this passing a point below 180 ft. or 46 ft, below MSL of the area, a spring overflew to 2 inches above the pit floor, yielding about 600 gph. Inspite of attempts to seal off same with wooden block and gunny bags, water continued to ooze out. Next cement injections through the bore holes to seal off cracks and crevices were attempted but to no purpose. Addition of prepared cement grout sealed off further flow and 172 ft. of sinking was completed. The pump was operating from 176th ft.

On the following day, that is 1st August 1948 the pumps were first found not to work properly. The water was found rushing up the pit. It was a grave predicament and a very sorry spectacle, as the party had almost worked itself up to win the bulk sample.

The situation worsened and got out of control with water steadily raising.

Brisk were the arrangements made for establishing the water bearing aquifer by injection of chemicals and cement.

Two electrically operated 25 HP centrifugal pumps were put into use. In the absence of any other equipment these weighing a ton each, were lowered into the pit and kept thereon to pump by human endeavours. Fortunately one of these dewatered efficiently and reduced the pressure of water enabling the other to put into use, with the result, the pit was dewatered to some extent. After 38 hours of continuous working by both the pumps under these very extrordinary handicaps, within a small space which allowed no other machineries to be put in, water level was kept at 156 ft. The pumps failed to perform and water rose up again at an alarming rate of about one foot a minute. The non-functioning pumps had to be quickly withdrawn. Human resources were tried to the utmost and the absence of suitable machineries in an emergency of this kind was substituted by giant human strength put forth in saving the pumps from being flooded away. On recovering the pumps, they were found to be filled in by fine sand and as the make of water was assessed at 400 gph, it was reasonably hoped, that the pit could have been dewatered provided the entry of sand into the suction pipe of the pump had been prevented. A further attempt

was made at dewatering with a sand filter attachment. At this stage considerable risk to person was taken by the officer who entered into the pit, with two of his able assistants, to study conditions first hand underneath. As further pumping was considered dangerous, the shaft walling above the caved pit bottom was stabilised by proper packing, by placing into the cavity double cement bags filled with 2 : 4 proportion of sand and cement mixture. 600 such bags were lowered to support the wall before the pumps could be taken out. Then attention was diverted to boring holes in two rings around the pit for injecting chemicals and rapid hardening cement into the aquifer below the lignite. 22 such bore holes were made with a total depth of 4000 ft. Work under these circumstances in this pit was most regrettably abandoned for the time being.

While the boreholes were being put, attention was diverted on two sides. One was on the prospecting of the area and the other was the reopening of the first 18 ft. diameter pit. Bore holes in two rings were also put down into the aquifer above the lignite, around this pit, in advance of the sinking, and such borehole was charged and allowed to settle and stabilise in the aquifer above the lignite, before sinking was proceeded with, to a depth to which the burst occured in the 2nd pit.

As these operations were going on, boreholes were being put regularly and some private parties as well started boring in quest of water. The valuable data

obtained and correallated, fixed the extreme south location of the lignite field beyond the south bank of the river Vellar. Attention was diverted to finding out a lignite bearing area which might be cut off from the artesian aquifer by folding, halting or other geological peculiarity. As the attempt proved a failure attention was directed to the north. Here also the efforts were not encouraging. Then a turn to southwest was taken. This was again found unsatisfactory.

At last a turn to west was taken. A cross section of the area was got. A net work of boring round about this area gave a series of very encouraging results. At one point a maximum thickness of 89.9 ft. of lignite was touched at a level of 158.09 ft. and the average in this area worked at about 50 ft. of lignite and the ratio of overburden to lignite averaged 3 : 1. In this area, which is about a mile to the north of the first pit, a third pit was sunk 18 ft. in diameter. With advanced precautions in preventing an inrush of sand from the aquifer into the pit was achieved. By a process of injection of stabilising materials into the ground pit, was made more positive and more effective. The larger space of 18 ft. proved more amenable for work in the matter of stabalising. Taking full advantage of the experiences gained in the sinking of pits 1 and 2, all known difficulties were eliminated in the third pit, with the result from out of this pit, at a depth of 172 ft. a bulk sample was taken out. This was a very great return for a very perilous and exhausting job undertaken

and this stood in good stead for the immediate launching of the pilot scheme.

Looking back, we find that lignite was proved over an area 100 sq. miles, and 3 pit shafts had to be sunk through very soft water bearing sand stones and clays, involving in all 75 boreholes, with a total depth of 21,000 ft. from 1948 onwards.

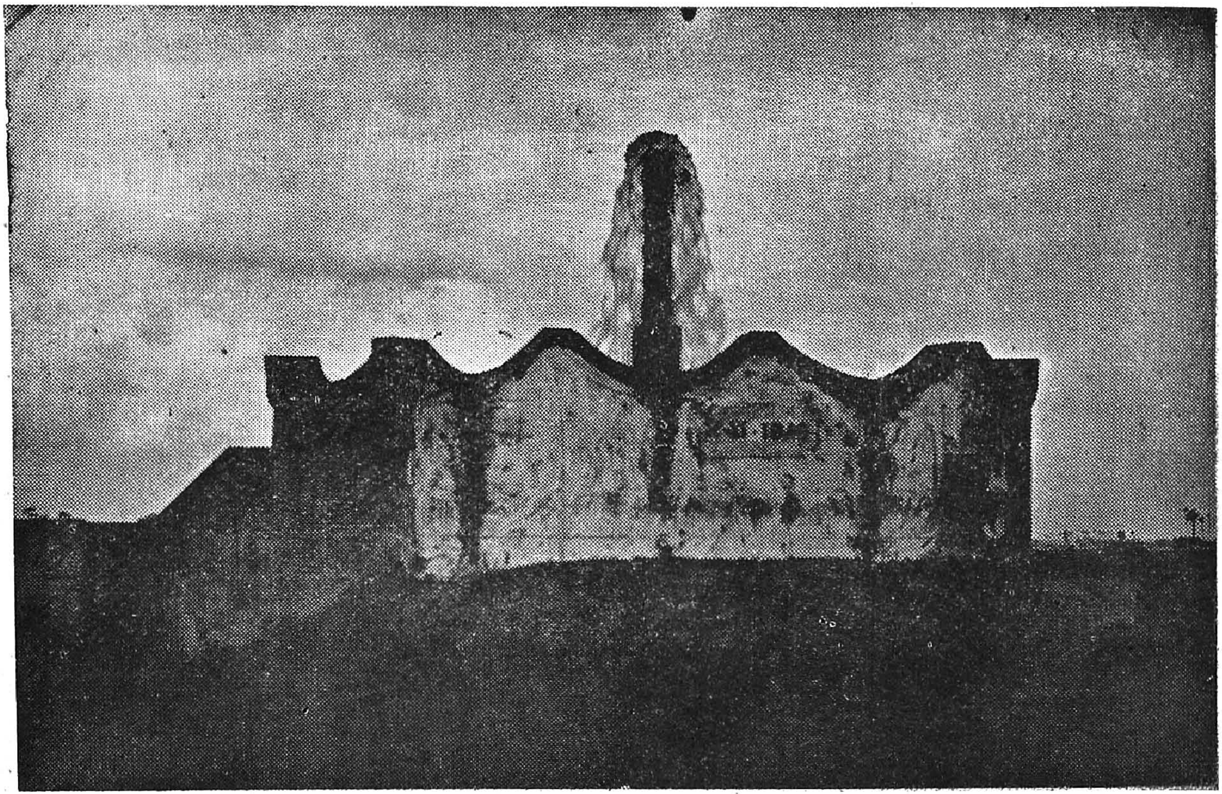
Many foreign Engineers and Experts had no ready solutions to the peculiar problems that obtained. Without machinery, equipment and staff, it has become possible for the Indian Engineer to show the way for the work to be done.

Artesian Aquifers

It is a hard truth that at present good waters stand in the way of South India becoming atonce industrially prosperous. It is all the more regrettable that since during late years, the monsoon had so utterly failed in this area, creating near famine conditions, that the very vast resources of good irrigation waters available in Cuddalore-Vridachalam taluks of the South Arcot lignite area should be considered undesirable. Such is the irony that what we long for most, some times on coming to us, may cause in us the greatest apprehensions During the investigation of lignite mining the possibilities of vast resources of water have become known to us. A study of the causes of the occurence of artesian aquifers and the nature of such occurence in these lignite fields have become part of the investigation for lignite.

The lignite fields lie with in the water shreds of Vellar river. From 1941 onwards, series of bore holes have been sunk in this area near about Aziz Nagar by the Industries Department. Private enterprises grew as well towards irrigating their lands by these artesian springs. Several bore holes were put down in Vridachalam and Chidambaram taluks with different yields. The Industries Department carried on the boring for the public as well.

The area prospected to the South of Cuddalore-Vridachalam road has a thick covering of aluvium over



ARTESIAN AQUIFERS

the Vellar - Manimukta river basin. This consists of dark to black clay. The northern half of the prospected lignite field is mainly arid, while the southern half is fairly fertile. Over this area various sources of irrigation exists, one of them being artesian wells. The existence of artesian aquifers in Oomangalam, Kammapuram and Kumaramangalam in the revenue firkas of Vridachalam taluk on the west, and Nangudi and Thurnjikollai in Chidambaram taluk on the south, and Pondicherry in the north, and Neiveli in the east where springs abound, are are the boundaries at present within which, artesian aquifers are proved at varying depths and of diffierent yields.

Though the ground water table in the northern half lies beaween 15 to 20 ft. of the surface, the supply of water in the irrigation wells is problematic, due to sharp variations in the occurence of productive springs within short distances. Whereas it has been found that one well in a property yields 400 to 600 gallons per day another in the same property, about a hundred yards away, does not even yield 100 gallons per day.

The expert opinion on this is, that the local variation in the permeability of the stratum may probably be the cause of this. Another peculiar feature which has been observed in this area is that, as one approaches the two hundred cantour line (MSL) of the region, the ground water table recedes and wells at this level even when 60 ft. 70 ft. deep are seen to contain only a foot of water even in rainy season.

The maximum and minimum temperatures are known to be 102 dg F' and 65 dg. F' respectively, giving an average of about 80 dg F'.

The District is situated within the region of regular course of monsoon. The average rainfall of the District is about 50 inches per year though every third or fourth years there had been in the past heavy downpour as well. The maximum rainfall in Cuddalore was in 1946-47 in recent years with 88 inches. Unfortunately after this, there had been successive seasons of drought.

Of the total rainfall how much finds its way into the underground water bearing beds in this area is difficult to assess. With a large proportion of clay beds and very little pervious material in the top beds in the tertiary deposits, here it is doubtful, if much water can find its way underground by direct infiltration. However, a certain quantity of rain water thus gets underneath, either through the out cropping pebble beds and Cuddalore sand-stone beds and or through cracks and crevices in the clay beds, to feed the water bearing beds. It is very doubtful whether such water can be the source of artesian aquifers.

Consideration of the disposal of the rainfall however is necessary. This may have a bearing on the course of investigation into the artesian water bearing sand beds at great depth.

When rains fall on the ground, upper layers are soaked or wetted at first. When the upper layer is soaked and gets saturated the water appears in visible

form on the surface. This water collects in trickles and runnels and flows towards the channel. But as it flows a certain quantity again soaks into unsaturated or dry ground in its course. Thus from the first there are two fold divisions of the rainfall, that is (1) that absorbed in the earth, (2) that which proceeds to the stream without being absorbed.

As for the absorbed water, a certain amount of this gets consumed by vegetation, a further amount is evaporated, the remainder slowly soaks into permeable beds underlying the surface and is finally removed from the influence of vegetation and evaporation. The ultimate fate of this last portion of water depends upon the geological structure of the catchment area. As a rule we may presume that this leaks away into the streams draining this area although the existence of such a phenomenon as artesian wells is sufficient to prove that exceptions occur and that in some cases sub soil water never again comes to the surface but escapes by underground passages to the sea or possibly into the interior of the earth.

A study of the effect of geological structures is necessary. The geological structure determines the catchment area. When this area is permeable, it absorbs a certain amount af rainfall and probably delivers a greater part of it later, acting as a concealed reservoir. The geological structure may also cause the true catchment area to differ from the surface area, and the run off to unusual extent may be influenced by this

Any condition that assists rain water to collect rapidly should also increase the run off. Whereas steep slopes, bare rocks and numerous well defined drainage channels help good run off, ill defined topography deter good run off. An area underlain by an impervious strata allows a large fraction of its rainfall to flow away on the surface which is cut and shaped by the flowing water into a topography favourable for a good run off. An area underlain by pervious rocks absorbs the rain and the run off occurs by ground seepage. In such areas the surface is not cut or shaped into a topography favourable for surface run off. The topographical formation of the Cuddalore - Vridachalam - Chidambaram lignite area is of this type, the run off being influenced by the large proportion of clay beds and aluvium occuring on the top.

A study of the records of the bore holes in this area has shown that the artesian springs come up to the surface with great force when the surface level is at or below 75 ft. cantour line. The maximum height at which water has been stated to have overflown is 122·5 ft. above MSL. The record further shows that water was first seen to overflow from a depth of about 195 ft.

Artesian wells have been seen to function over an area of about 100 sq. miles between parallels of longitude 79 dg. 24' to 79 dg. 34' and latitude 11 dg. 34' to 11 dg. 38' extending from Cuddalore-Vridachalam road to a little beyond the south bank of river Vellar. It is known that the tertiaries extend southwards beyond the

river Vellar and Manimukta river also hugs the tertiaries near Vridachalam and probably crosses these further down its course. The Vellar and Manimukta rivers must therefore be cutting through the pebble beds and Cuddalore sand-stones somewhere on their courses. The Vellar besin being covered with a thick layer of aluvium of black clay, good exposures of the underlying rocks are not easily visible anywhere.

The tertiaries extend to west and south as well. The pebble bed is seen to occur to the south of the lignite field. It therefore seems possible Gadilam and Ponniar rivers might be the source of recharge to the basin.

Unless the recharge area is very large, the annual rainfall in the District is not enough to keep the artesian basin so charged, that the artesian wells in the area should continue to yield water virtually, un-diminishingly over a number of years.

If the recharge area is small the supply in the artesian wells could not have been maintained for a long number of years. Most of them might have been dried up by now.

Failure of a particular well or two, as is known to have occured, cannot be taken as a failure of the artesian aquifer in the region. This may be due to defective casing. It is definite that some perrineal source keeps the artesian aquifers fully charged. It may be that the pebble beds which are crossed by the Ponniar and Gadilam which is crossed as well by the Manimukta and

Vellar rivers is one of the recharge inlet for the artesian aquifers. The Cuddalore-sand-stones are also the probable channels for the passage of the rain water and river water underground. These may at best be conjuctures only and a complete study of the problem is necessary. A geological and geographical mapping to determine the location, extent and thickness of the water bearing formations are necessary. A complete hydrologic mapping, a physical study to determine the permeability and porocity of the different layers of tertiary rocks and particularly of the strata containing the aquifers, a correct estimate of the water that enters the aquifers and that draining out, a determination of the direction and rate of movement of the water and a determination of the area of recharge and discharge are necessary and immediate investigations are to be undertaken by a geological mapping of the areas correlated with datas obtained from core bore drilling operations, by pumping water from test bore holes which should include both artesian and non-artesian wells, and by electric and gumma-ray logging.

The useful information gathered so far from the bore holes are, the existence of a horizon of pressure water above the lignite, that a layer of lignite is seperated from the artesian horizons above and below it by layers of impervious clays, that lignite has no bearing on the occurrence of aquifers, that the aquifers are held between aquicludes which may either be lignite or impervious clay beds.

It is guessed that the flow of water may be from the north east direction.

The investigation also goes to show that the artesian aquifers may have no connection with sea water, that is Bay of Bengal, which is about 18 miles east of the known western boundary of the lignite fields. The water seems to be confined to the Cuddalore sand-stones with in a limited, though a large area, probably due to the irregularities in geological peculiarities.

A series of boring operations were undertaken in the exploitation of lignite and it was found that there are more than one aquifer and some are artesian in character ; that the aquifer below the lignite is the most powerful ; that water rises upto different heights above ground level depending on the reduced level of the ground at the site of the bore hole. The artesian aquifer above the lignite is not powerful enough to shoot much above ground level and under favourable conditions overflow 1 to 2 ft. above ground level and the quantity from the aquifer vary from 10 to 15 gallons per minute ; that the aquiclude above the high pressure artesian is generally a stiffy clay often of a carboneous character ; that the artesian spring does not attain its maximum yield till a very large quantity of fine sand has been washed out of the bore hole.

It may be safe to assume that this area contains underneath vast resources of water. These are artesian aquifers and can be brought to ground level for utilisation. A heavy draw on these waters may however dry

up the springs, as in London and Algeria. From records available, the very heavy draw on London basin during the last 20 years, inspite of fluctuations due to unusually wet or dry years, fell at a rate of 18 inches to 3 feet per annum. The artesian wells in Algeria also show a considerable decline since 1900. But, however, in this case, considering the very vast area, it is doubtful whether a few artesian wells bored in this area, could appreciably reduce the artesian water table. It is safe again to assume that the re-charge these aquifers get is fairly large and the aquifers collect water from a vast source which at present is invisible. The value of the aquifers are such that an independent investigation is necessary and the available data are encouraging.

For a fuller knowledge of the source causing artesian conditions, a thorough study of the following factors are necessary. (1) The stratagraphy of the areas, (2) The extent of the tertiaries and in particular the extent, thickness and position of pebble beds and Cuddalore-sand stones, (3) Average rainfall for the past 50 years over the District, (4) Average annual run off in the rivers sorrounding the field and (5) The permeability and porocity of the various rocks from top downwards.

Under the Indo - American Technical Co-operation Agreement No. 12, a team of geologists under the leader ship of Dr. P. K. Ghose, Superintending Geologist, Engineering Geology and Ground Water Section, Geological Survey of India, studied and explored the ground water in Neiveli.

Various sources of irrigation exist in India and one such is artesian aquifers. At present 75 percent of the irrigation in India is carried on from wells. Even if all the dams are completed in construction, 25 per cent of the irrigation in India can only be from wells. It is of interest to note that in India well irrigation is the largest in the world.

Under Point 4, the services of Mr. George C. Taylor, Jr., Ground Water Geologist, United States Geological Survey, is lent to the G.S.I. and along with Mr. M. S. Balasundaram, Senior Geologist, G.S.I., and Dr. A. K. Day, Deputy Director G.S.I. (South), the team is making a survey of India, exploring the possibilities of tapping underground water, all over India. The thick aluvium beds, the unconsolidated soft rocks, are dealt with in the first instance. Such beds abound in Gujaret, Sourashtra and along the foot of the Himalayas, near about Rajamundry in Andhra and in Travancore Cochin State. At present the team is on the Coromandal coast. It is proposed to put 350 bore holes in the country, of which Madras is to get 50 and Neiveli region alone is allotted about ten. Andhra State gets 20 and Travancore-Cochin 5.

The scheme is estimated to cost about 3.5 crores of rupees of which the U.S.A. will be footing 2·2 crores and the Union Government 1·3 crores. This is just a a preliminary of the preliminary of efforts to assess the ground water wealth of India and the scheme is bound to take a huge shape in years to come. The

object of the team is to pave the way for this huge undertaking and to train sufficient personnel to take up this kind of work.

Artesian aquifers are known to exist for centuries in South Arcot. The State Government anxious to utilise these large quantities of the waters, have formulated schemes by which they had completed sinking 20 wells in the first instance. The State has further added another 101 and 5, totalling in all 126. It is of course true in some of these wells the quantity of discharge is getting diminished.

Mr. Taylor observed that in Mexico, a sad experience resulted by ripping open too many artesian aquifers which caused diminishing of discharge. When the drawing of water was greater than that of the charge, this result was inevitable. It is therefore necessary to control the discharge of water. This can be achieved by spacing properly the bore holes. In U.P. actually a space of a mile is given between bore hole and bore hole which is just about proper spacing. By boring too many bore holes the basin gets diminished and sometimes instead of overflowing, it becomes necessary to pump, which in turn adds to irrigation charges. Instead of availing what nature gives, conditions are made artificially more difficult. A sound device is practiced in one of the wells here by putting a valve to conserve water. This prevents waste of water. Water drawn and not used is not only a waste but work on the basin and causes water logging which in turn affects the

soil. In all bore holing, it is absolutely necessary to draw only the required quantity of water and to preserve the borehole for future requirements. Bore holes have thus to be nursed and in these parts, it is felt, the number of bore holes are too many.

The immediate work of the team will be to bore to a depth of 1000 feet even if necessary, in the ten bore holes proposed. It is proposed to do electrical logging, chemical analysis of water and make a study of logs to determine the flow of water and the quantity of water in the basin and the amount of recharge, the basin gets.

Tests On South Arcot Lignite

In the tests carried out in the various laboratories of the world, the results in general hereunder, are found to be very encouraging.

1. The moisture content for this class of fuels is fairly low.

2. The ash content is generally low.

3. The sulphur content is low.

4. The calorific value is very high, comparing favourably with Grade 1 coal of Bengal.

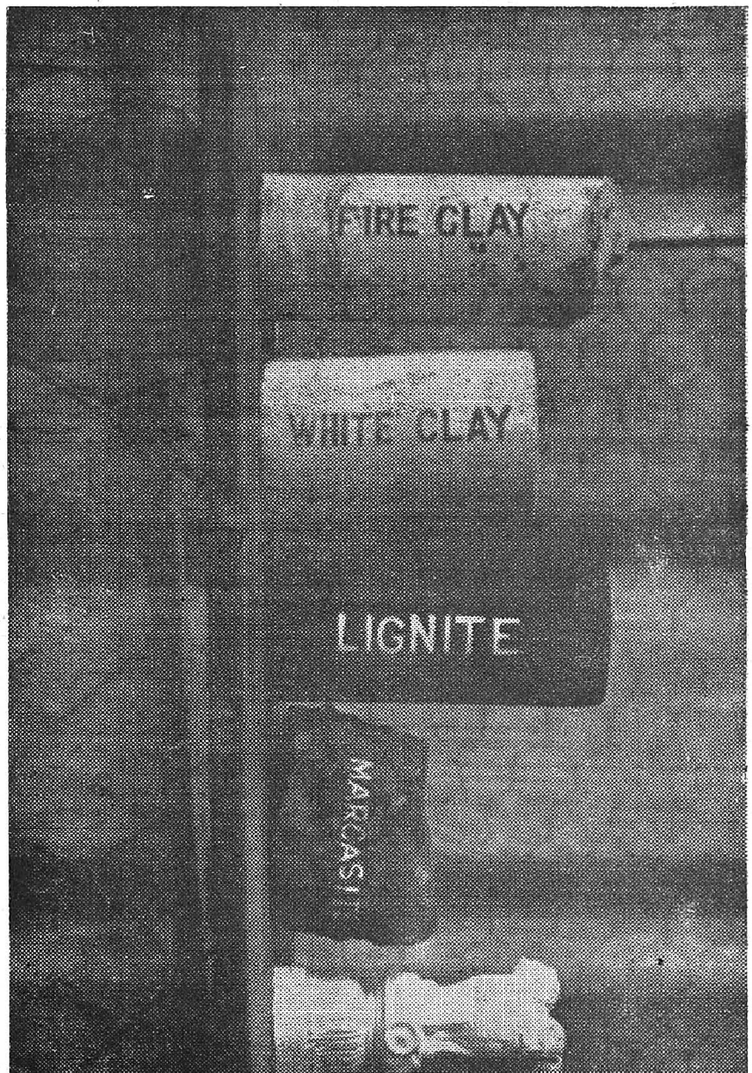
A comparitive statement of analysis of Lignite in several countries is as follows :—

	Germany	Australia	Bikanir	S. Arcot.
Moisture	59%	65.23%	25%	15.08%
Ash	2.40%	0.69%	5%	3.20%
Volatiles	21.20%	17.68%	35%	44.78%
Fixed Carbon	17.40%	16.43%	35%	36.94%
Phosphorous	No information ...		...	Traces
Sulphur	do	do	3.24%	1.16%

Calorific value B Th U

Wet	4,450	3,780	
Dry	11,000	10,870	11,000
Specific Gravity	—	—	0.89

It is seen that the moisture content of South Arcot lignite is comparitively lower. Whereas predrying before use is necessary in respect of other lignites, this



TEST ON LIGNITE

TESTS ON LIGNITE

may be used as it is. Experiments conducted at the G. S. I. laboratories Calcutta, Fuel Research Institute Dhanbad and Experimental Mineral Testing Laboratory, Government of Madras at Washermanpet, and also in Norway, indicate a fairly low percentage of moisture content, not exceeding 15 percent. It is also known that lignite takes up a lot of moisture when immersed in water and gives it up also very soon when air dried. The experiments carried out by Dr. Whittaker, Director, Fuel Research Institute of India, had shown that the moisture content could be reduced on heating to 110 dg. C' but on cooling lignite is known to have reabsorbed 8 to 9 percent moisture leaving 3 to 4 percent moisture as totally lost. The following analysis by the Coal Blending and Coking Research Sub Committee is interesting :—

Proximate analysis.

Total moisture (as received) 12.30%

(8 to 9% absorbed when left in the atmosphere)

Ash - 5.84%

VM - 49.46%

FC - 44.70%

Total sulphur 0.846

Phosphorous in coal - traces

All these are on dry basis.

The following are the detailed results of experiments carried out in different laboratories. Though the results vary and sometimes sharply too, the results are not far to seek. The results are self illuminating.

EXPERIMENTAL RESULTS ON S. ARCOT LIGNITE IN DIFFERENT LABORATORIES.

	Moisture	Ash.	V.M.	F.C.	Sulphur	Phos.	B. Th U wet	B. Th U dry
M/s Elektrokemisks	11·8	3·6	36·1	48·5	...	...	...	...
A/s of Oslo, Norway	15·7	6·2	37·7	40·4	...	...	...	...
M/s Lurgi Geseellschaft fur Waermetechmik	36·0	3·3	31·4	29·3	0·56	0·41	...	...
m.b.H. Germany	22·8	7·0	37·5	32·7	0·52	0·41	...	...
Power Gas Corporation, England	12·3	13·6	42·9	34·7	...	...	9375	10680
Federal Institute for the Examination and Experiments of Materials	20·1	12·6	38·9	28·4	...	...	4357	...
for Industry, civil Engineering, Handcrafts, Zurich	13·5	13·6	42·1	30·8	...	...	4722	...

Director Fuel Research Station, U.K.	21·1	4·6	46·8	27·5	0·7	...	12010	...
	36·6	5·0	33·4	25·0	0·9	...	10590	...
	18·4	6·5	40·3	34·8	1·1	...	10520	...
Coal Blending and Coaking Research Subcommittee	12·3	5·84	49·46	44·7	0·846	...	...	...
Fuel Research Institute Dhanbad	23·5	5·5	39·3	31·7	...	...	8510	11120
	11·5	40·7	29·4	18·5	...	...	5654	6370
	22·3	5·9	37·6	34·2	...	...	7972	10260
	17·8	8·7	36·9	36·6	...	...	8130	9890
	49·8	6·2	23·5	20·5	...	...	5180	10320

EXPERIMENTAL RESULTS OBTAINED BY Dr. B.S. SRIKANTAN AT EXPERIMENTAL MINERAL TESTING LABORATORY GOVERNMENT OF MADRAS.

		Moisture	Ash,	V.M.	F.C.	Sulphur	Phos.	B. Th U wet	B. Th U dry
1. Neiveli	Ry. station	24·5	16·2	33·9	23·4	1·03	...	6481	8540
2. Do.	Do.	19·40	4·17	38·09	38·34	0·56	...	...	...
3. Do.	Do.	21·30	4·55	38·71	35·44	0·66	...	...	...
4. Do.	Do.	9·35	40·85	28·61	21·19	0·50	...	...	...
5. Do.	Do.	20·73	5·58	37·6	36·07	0·54	...	...	...
6. Do.	Do.	21·52	6·48	34·74	37·26	0·56	...	...	...
7. Do.	Do.	29·43	8·41	33·17	29·29	0·61	...	...	...
Dharmanallur		14·4	7·9	33·1	34·6	0·63	...	9012	10538
Perur		15·4	4·8	42 9	36·8	0·63	...	9546	11290
Do.		12·1	10·2	10·3	36·4	1·03	...	8888	10230
Velayudhampattu		19·7	4·2	39·6	36·5	0·88	...	...	...
2. Do.		19·4	4 5	39·7	36·4	0·82	...	...	...
3. Do.		17·3	7·1	39·4	36·2	0·91	...	...	...
4. Do.		17·2	6·8	39·3	36·7	0·98	...	...	...
Gangaikondan		13·6	17·86	38·65	28·99	0·72	...	...	...
2. Do.		17·85	14·92	35·21	32·02	0·61	...	...	...
3. Do.		18·7	16·63	34·92	29·58	0·62	...	...	...
Keeramangalam		15·3	6·57	41·40	36·67	0·53	...	...	...
Vepankurichi		15·79	5 02	39·69	36·50	0·81	...	...	...

Uses And Utilisation Of Lignite

Direct or Run of Mine. — in industrial boilers

The most simple and rational use of lignite would be its direct use in boilers for the generation of power. It is considered that run of mine lignite could be used in industrial boilers by a little modification of the grate arrangements.

In Australia and in Germany the percentage of moisture in lignite is high, varying between 50 and 60% This necessitates installation of suitable predrying and preignition equipment with their boiler installation. As the South Arcot lignite is known to contain only 10 to 15% of moisture, it is wondered whether it can be fed directly into chain grate stokers. Perhaps some modification may be necessary. The fly ash is a distinct possibility in the matter of anticipated troubles and as this crops up, a modification in the grate arrangement may be thought about to get past this. In Australia they are known to have adopted a pre-drying and pre-ignition method for efficient combustion. The fuel stream is dried by the flue gas and ignited before it reaches the grates, thus ensuring a good combustion.

Glass and Nitrate Industries

In Germany brown coal is preferred to bituminous coal, in glass and nitrate industries. Better results, are reported.

Messrs Lurgis of Germany are of opinion that South Arcot lignite can be used for the recovery of sulphur from gypsum.

Lignite is exclusively used in Germany and Italy in their cement factories.

As Lignite is known to give better results than slack coal, probably owing to the lower heat value and to a more uniform rate of burning, brick burning klins in Bikanir prefer lignite to slack coal.

In pulverised form

Liginte is crushed in suitable crushers and then fired in combustion chambers of suitable construction, in pulverised fuel firing boilers. The other method of mill firing is mostly used in Germany. The chambers are like pulverised fuel firing ones. Lignite is crushed in suitable grinders and fired into the boiler chamber through suitable nostles of varying numbers—two, three or four. The boiler installation is designated by the number of nostles used.

German mill firing is divided into two groups. In the first, the burners are arranged in the front wall of the furnace only, the method being applied for boilers of about 50 ton capacity per hour. The corner firing is applicable for larger capacities.

The minimum boiler rating with mill firing is about 50% though with four mills and corner firing, lower rating can be reached. It is known that the Elbe Power Station is using coal of 50-50%. Water content

TAMIL ... LIBRARY
ACC. No. 51 398
EGMORE, MADRAS-600 008

boilers can be operated satisfactorily at approximately 33% rating.

Use in Gas Turbines

Experiments are in progress in U.S.A., on the use of solid fuels in gas turbines. The South Arcot lignite, it is hoped, will cover this field as well.

Uses in briquetted form

Since the lignite on giving up moisture starts crumbling, it has to be processed for storing and conveying to long distances. This is particularly necessary to minimise the risk of automatic cumbustion in storage or transit.

The Germans experimented to know whether the lignite could be processed to a sufficiently compact briquette to withstand weather and handling. The lignite was pressed in a ring roller press to about 1500 lbs. p.s.i. to produce cylindrical briquettes. They were polished black. The reports stated that these were not resistent to water and they started disintegrating when immersed in water for 30 minutes.

The second experiment was the process of carbonising the lignite at temperatures of 500 to 600 deg. centigrade. These were harder and reported to be resistent to water.

The German report ran, " Messrs Elektrokemisks of Oslo, Norway, prefer utilisation of carbonising coke as a reducing agent for electric steel furnaces. In the case

of South Arcot lignite being carbonised and briquetted, an abrasion proof hard lumpy coke of excellent reactivity will be produced. This fuel can be utilised to a large extent as a reducing agent for electric steel furnaces."

The Swedish experiment of briquettes was produced by a combined grinder and power press. It was not known to disintegrate when kept in water for 36 hours. Swedish lignite press is comparatively a cheaper plant than the German ring roller press.

Briquette firing boilers for industrial purposes are in the increase in the State of Victoria, Australia. The Victorian Electricity Commission has succeeded in developing a modification to the ordinary chain grate stoker, to enable lignite briquettes being used as fuel. By the use of equipment briquettes are burnt satisfactorily and the output of a boiler is comparatively higher than that of one with ordinary fuel. Briquettes produce inoffensive, light white smoke only.

The Victorian Electricity Commission generates electrical energy in a 18000 KW turbo alternator, driven by super heated steam at a pressure of 150 lbs. per sq. inch. This steam is provided by 18 Badcock and Wilcox boilers of a semi-horizontal water tube type with two common economisers to deal with feed water. The boilers are equipped with B & W chain grate stokers and fuel is fed from overhead bunkers, into which it is conveyed by bracket elevators and scrapper conveyors, from the end of the boiler house, They

were originally using slack brown coal, The necessary alteration to the chain grate was made to burn brown coal briquettes and to provide for a rapidly fluctutating load by the provision of a device for rapidly igniting the fuel, the ordinary ignition being insufficient for this purpose. Therefore a small pre-ignition grate was improvised and attached at the bottom of the hopper. This ignites the fuel stream from below as it starts its travel on the grate. The boilers with this installation operates at 200% of makers rating, and 4 boilers carry the entire load of the station.

Experience with briquettes has proved that the constant high efficiency is obtained over a wide range of loading, giving a beneficial overhaul efficiency. The use of the briquettes also has proved economic, with the new fuel. Previously private factory Engineers had considered black coal to be the only suitable fuel of high steam output from chain grate stokers. Many industrialists are already turning to lignite briquettes. Owing to the absence of clinker and ash, the running charges are comparatively less. and the installation charges are slight. Briquettes are also smokeless in combustion reducing to the minimum the nuisance suffered by adjacent property owners.

Consumption figures for 10 hours briquettes, in a semi automatic Swiss installation with two men are —

Period of work of machinery	Man Hours
7 hours	14 hours
Current Consumption	Lubrication
140 KW h	1¾ lbs.

7200 briquettes hourly corresponding to 30 cwt. of lignite briquettes.

On the above data the cost of briquetting can roughly be taken as Re. 1/8- per ton, the cost of such machinery being about Rs 57,000/-

Bituminous Bye Products

The bituminous content is directly connected to the hydrogen content. The bitumen content recoverable by solvent action is known as monton wax and is largely used in floor polish, boot polish, cable wax, lacquers for gramaphones and for candle manufacture after bleaching.

Monton Wax

Monton wax is a dark brown wax melting at 80 dg. centigrade. It consists generally of easters of montanic and similar acids. It also contains some resinous " ashphaltic material "

It is also used in the manufacture of phlegmatising explosives. Monton wax is also used to produce fats, lubricants and deisel oils. Experiments carried out on South Arcot lignite showed that the lignite contained 10 to 12%, by xylene extraction.

The importance of the product can be appreciated if it is known that a six foot lignite bed at a depth of nearly 600 ft. is gone into in UK and this yields just about 4% of monton wax.

The character and compositon of South Arcot lignite varies and with it, the percentage of bitumen

content also. It is considered that peaty and woody varieties which form the bulk of the lignite bed, yield a larger percentage of monton wax. Such wax, it is learnt, can be economically extracted when the content is 10%. Though the Germans are the largest producers of monton wax, Czechoslovakia, Australia, Russia and a few others, also produce this wax. The percentage of their yield is comparatively less.

Plastics

Manufacture of plastics is another line from lignite. Brown coal of high lignin content with about 12% of its weight of cresol at a temperature of about 90 dg C and suitable treatment are moulded for plastics under a slight pressure. Organic bases are also used successfully in place of phenols. After removal of the solvent used to introduce the re-agent, the coal mass is moulded or pressed at about 150 dg C under about 2 tons psi. The moulded material yields to turning, drilling and polishing. It is highly resistent to corrosion. It is odourless and has good insulating properties. The cost of this coal plastic is comparatively less than bakelite.

Bye Products

The Lurgis (German) experiments and reports show that the low temperature tar can be worked up into motor fuels, deisel oils, heating oils, impregnating oils, pitch, and carbolic oil, by different methods. From carbolic oil, it is possible to obtain cresols and phenols, which can be used for the production of disinfectants and artificial fabrics in phenol bases. They have recommen-

ded using the gas obtained from the low temperature carbonisation, in heating carboniser after the gasolene has been extracted.

The following report of Messrs Lurgi Geselleschaft fur Waermetechnik mbH of Germany. on the production of metallurgical coke from a mixture between our lignite and iron ores, is interesting reading.

"It was succeeded in producing extremely firm briquettes and a lumpy scarcely staining hard coke from a mixture between S. Arcot lignite and two different kinds of lothringian minette. The quantity of the minette to be added, can be increased to approximately 30 to 35% of weight, without affecting the qualities of the briquettes and the coke. The mixed material after having been prepared to a grain size of a less than 1 mm (material obtained by shock drying) with a water content of 7 to 8% is briquetted under a press power of 1500 kg - sq, centimeter (ring roller press). The carbonising temperature is 800 dg C. With this mixture containing 30 to 35% minette, the standard mixing proportion for a blast furnace process namely one particle of coke against one particle of ore will be attained........In view of the results hitherto obtained from the tests, however, a satisfactory result is to be expected in this case also.

The quantity of coke required for a blast furnace process is generally almost equivalent to the quantity of ore to be employed. This requirement is met for an output of 66·3% of coke (dry) by a mixture of about 68% of South Arcot lignite (7% of water) and about

32% of minette, a mixture which is theoritically favourable also with regard to the properties of coke.

Further trials in Indian laboratories with Indian iron ores have confirmed the results.

Use as Carbonised Briquette

Though raw briquettes can be used, it is better to carbonise briquettes for uses and following are some of the purposes to which it can be put into :—

1. as a domestic fuel
2. as a fuel for industrial boilers
3. as a blast furnace coke in low shaft furnaces
4. as a reducing agent in electric furnaces
5. as a fuel for gas producers
6. for production of water gas or town gas.

Production of Activated Carbon or Carbon Black

Lignite is carbonised in special retorts to produce activated carbon. Our imports, at present, are large and costly for this product. Experiments carried out confirm that activated carbon produced out of this lignite compares favourably with foreign products and our industrial requirements should be met in full.

Lignite is also a soil improver and the heaps of slack and dust in handling should yield valuable result.

Utilisation of South Arcot Lignite

It is only after subjecting this lignite to a thorough, ultimate, proximate and microscopic analysis and sub-

jecting to rational analysis, qualified chemists can tell us the various uses to which it can be put into. What bye products and to what extent these can be got out of the lignite can only be known after detailed experiments.

Lignite may be used raw :—

(*a*) 1. For generation of power
2. for industrial purposes
3. as a soil improver.

(*b*) may be briquetted and used
1. for generation of power
2. for industrial purposes
3. for domestic uses.

(*c*) may be used for manufacture of plastics after suitable treatment.

(*d*) may be subjected to oxidation and or hydrogenation to produce motor benzol and other light and heavy oils.

(*e*) may be subjected to oxidation to produce various acids:— 1. acetic, 2. ozatic, 3. benzoic, carboxlic etc. etc.

(*f*) the tar obtained may be subjected to various treatments to yield a vast number of bye products.

(*g*) may be used for extraction of monton wax.

(*h*) may be chlorinated or oxadised or nitrated to produce tanning materials.

(*i*) the humic acid and ulmino can be nitrated and after reduction to amino form, can be diozotised to produce yellow and brown dyes.

(*j*) fractional distillation may yield toluene (base of tri Nitro-Toluol, a high explosive), saccharine (source of greatest sweet), various medicines, naphthalene, cresote, carbolic acid, etc. and fertiliser (ammonium sulphate) etc., etc.

Overburden Clays

Before reaching the lignite bed, the overburden encountered consists of clays of different structures. The first twenty feet is yellow clay with gravel. Then white and rose clays followed by rose red clays to a depth of about 20 ft. are found. White clay with sand and gravel are found in the next 10 ft. The following 20 ft. is soft rose red clay. The next layer of about 15 ft. is yellow clay with white patches. White clay and white moram with sand take up the region between 80 and 100 ft., immediately followed by 5 ft. of soft white clay with violet patches. White clay with sand and white clay with rose red patches occupy the space of about 40 ft. between 105 and 140 ft. There is a strip of sheet of white clays with sand followed by 5 ft. of white and rose red clays. After a layer of about 6 ft. of hard white clay there is a 20 ft. bed of white clay with sand. Immediately above the lignite occurs carbaneous clay with marcasite band.

Tests carried out on some of the clays found thus had yielded excellent rasults. The report of the Ceramic Expert, Government Ceramic Factory, on clay at a depth of 70 ft. is as follows :—

" We have carried on tests on all the four clays in which we found white clay sent in waggon load has proved to be good for the manufacture of bricks. Further tests are being carried out for the manufacture of saggers." On a second batch of samples sent from depths between 150 and 162 ft. it is reported thus :—

"Fire bricks of standard size and saggers were made out of the clay in this plant and fired in our commercial klins to 1300 deg C and above. Even at this high temperature, the sample bricks remained fairly porous and did not show any sign of fusion. The clay is free from objectionable materials (impurities) like iron pyrites and lime nodules etc.

This is the best sample of clay which we have come across so far in this State in its refractiveness and general properties though lacking in plasticity. We have been using Tindivanam and Bommur fire clays for making saggers in this plant. Both of them are quite inferior when compared to this sample, having lime and iron pyrites and other impurities. If this clay is made available to us in sufficient quantities we would be able to improve the quality of our saggers and also its life and thus economise production to some extent. This clay no doubt supplies the long felt need for proper type of fire clay in our State. It would also be possible to take up the manufacture of refractories and produce fire bricks of standard quality in this plant provided sufficient quantities of this material are made available to us at competitive rates."

The following is the analysis of clay sample obtained at greater depths in the area.

	Fire clay 271'-273'	China clay 269'-271'	Fire clay 279'-281'	White clay 281'-285'
Loss -	18·50%	18·46%	16·62%	16·68%
SiO_2 -	29·89%	20·45%	41·32%	20·92%
Al_2O_3 -	40·60%	60·20%	40·28%	60·90%
Fe_2O_3 -	1·20%	1·80%	0·80%	1·60%
CaO -	...	...	...	...
MgO -	...	...	...	...

Examination of clays by Dr. B. S. Srikantan

Table I

1.	Appearance	Very pale buff colour
2.	State on powdering	Smooth non-gritty easily powders to 80 to 100 mesh
3.	Plasticity (water percent)	35
4.	Air shrinkage (86 dg F)	2.5%
5.	Fire shrinkage (1742 dg F')	9.0%
6.	Porocity of the dried product (1742 dg F)	22.0%
7.	Tensile strength (briquettes)	
	Air dried at 36 dg F for 24 hours	- 13·5 psi
	Dried at 230 dg F for 8 hours	- 22·1 ,,
	Fired at 1652 dg F for 6 hours	- 31·1 ,,
8.	Colour after firing (1742 dg F)	- whitish with traces of buff
9.	Temperature of fusion -	- not below 2012 dg F

Table A.

1. Silica in combination	- -	34·25%
2. Do. hydrated	- -	2·52%
3. Quartz	- -	8·09%
Total	- -	45·12

The usual alumina percentage in standard fire bricks does not exceed ·35 and is normally much below this. For making refractory bricks, because of the low alumina

content, some factories mix bauxite. The alumina content of the major part of the clay is over 35% and as such, this is suitable for the manufacture of fire bricks without enrichments. Some have high alumina content and some are milky white and unctuous in character, The alumina content averages 60%. These can therefore form the basis of a ceramic industry.

The clays, it is known, can also be treated mechanically to produce alumina as is being done in the USA. Potteries and firebricks were made out of these clays at the spot. The bricks tested at a temperature of 1400 dg C withstood the heat and discolouration and fusion as well. The bricks stood a load test of 800 lbs psi.

The bulk of the material is nearly pure koalin. The iron content is particularly low and the baked product did not show any undesirable colour. The ratio of non-detrimentals to that of detrimentals are :—

$$\frac{SiO_2+OI_2O_3+TiO_2}{Fc_2O_3+K_2O_3+Na_2O+CaO+MgO}$$

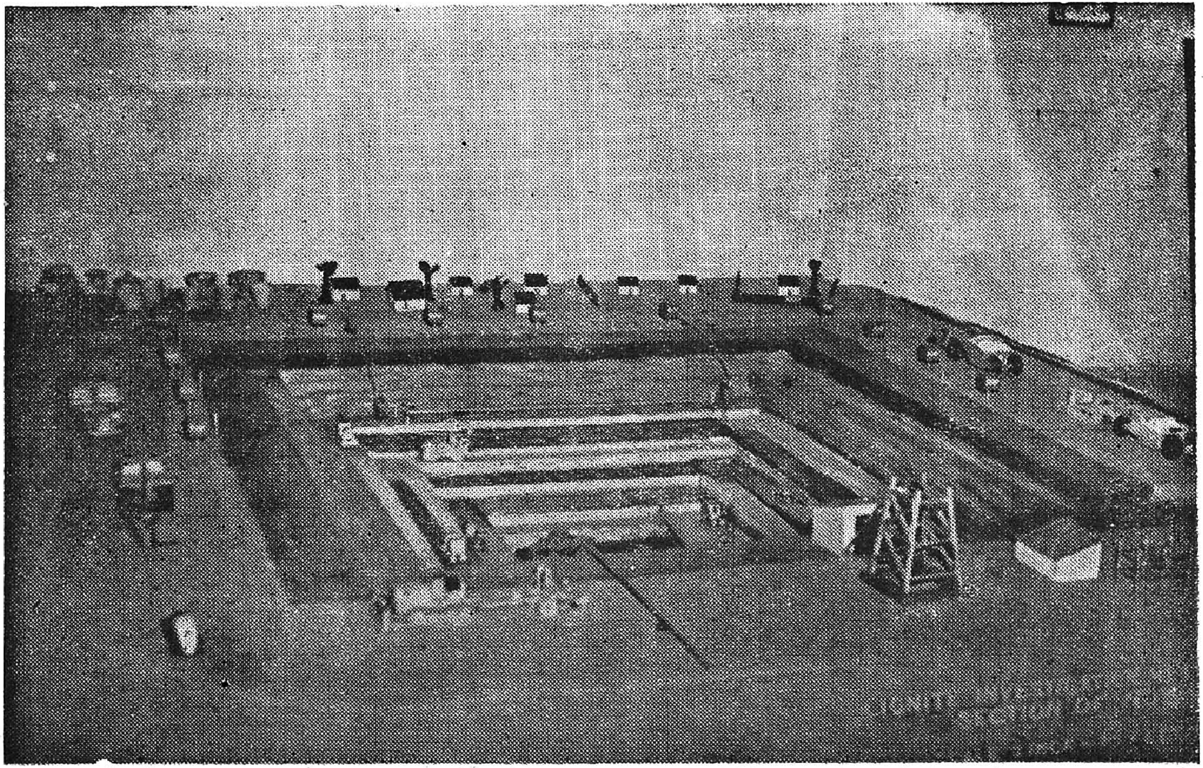
This is as high as 41. It can be concluded that melting point of the clay will not be below 3200 dg F. The shrinkage when heated from ordinary temperature to 1652 dg F is 25 to 90%. This is not very high. Refractories are always heated to higher temperatures during their manufacture than under service conditions. This is good quality fire clay having a porocity of 22%. Porocity could be further improved by mixing it with

'grog' or 'chaff' and burning it to make it a light weight refractory.

For white wares and other uses

Virginian clays of similar composition are being used straightaway for the manufacture of white wares. The trace of pale buff colour could be diminished in the fired product in processing and glazing. The plasticity of of the clay is 35% of water. The tensile strength is low but could be improved by ageing or by addition of agents. Mixed with the requisite amount of quartz or felspar it could be cast into insulators, acid jars, sanitary wares etc. Whiteness and freedom from grit suggest that the clays could also be used as filters in paper, paint and soap industries and for washing and bleaching in textile industries.

The clays are found useful in the manufacture of high alumina bricks, colouring chalk and cryon pencils. It is understood Messrs Dalmia Cement, Tiruchy, have arranged to take a good load for trial and use of this clay in their varied lines. Results are awaited.



MODEL OF QUARRY

MINING

Mining

A very promising area with a thick layer of lignite is found around pit no. 3 in Thandavankuppam village, which is about 1 mile from Neiveli Railway Station.

A detailed prospecting by a close net work of boreholes was undertaken in this area. Detailed surveying was also completed.

In view of the fact that suitable machineries are not available, the most difficult and yet not unsurmountable problem is undertaken in a simple way. Planning, though it cannot be too much in advance, is made in this instance by the launching of the Pilot scheme. It is hoped the difficulties to be met with, will be known and on this, development can proceed. A market necessarily has to be created as well and developed by propaganda, demonstration and organisation. The pilot scheme is intended to choose the size, type and number of machineries and equipment to be used in exploitation of the lignite economically.

The layer of lignite varies in thickness in this area from 55 ft. to 89·9 averaging about 60 ft. and the overburden averages 180 ft. This gives a very encouraging coal to overburden ratio of 1 : 3. With the help of the study of the underground conditions in pit No. 3, high alumina clay are known to occur at the following horizons :—(a) 70 to 80 ft. (b) 100 to 110 ft. (c) 140 to 150 ft. and (d) above the lignite. The last three layers are treacherous as they are silken sided. The

last one has not been exposed and hence its character is yet to be studied. It is known that so long as they are kept dry, they stand a fair amount of pressure but with water they may start sliding, particularly when undercut. As these clays have not been allowed to stand exposed for a long time in the pits, it is not known how they will stand when stepped. It is certain that unless the clay beds are kept dry, they would become slushy and start sliding with the movement over them of heavy quick moving vehicles, probably even when sloped.

There is therefore need for study of the crushing strength of the various layers when wet and dry. It is hoped that if they are kept dry the amount of pressure caused from walking drag lines, tractors etc., can be withstood. It is considered that the soil could be kept fairly dry with the help of well point system of pumping as and when necessary. The well point system of pre-drying has been successfully employed in various parts of the world in pumping sea dykes, ports, docks, river dams etc., even on clayey soils and it is expected to work with large size excavating machinery and other types of pumps. The actual working arrangements should however depend on the actual water conditions in each layer as the excavation advances. The job could certainly be best and economically done by the use of large scale excavating machineries.

Machineries and equipment have to be procured from abroad. Considerable are the difficulties experienced

in procuring same. In addition to involving of large amounts of outlay and inordinate delay caused in getting them, further difficulties threaten as well, as regards the choosing of the right type of machineries, equipment and their numbers. As these may depend on the actual state of affairs and conditions and this can only be known after working the pilot scheme, the exigencies of circumstances have made the Engineer content himself with making the best use of aviala-bilities.

With the knowledge of the needs and a search round the disposals, a collection of the items had become possible from the stock of the Union Government which are being assembled and being made use of.

After the selection of the site for the pilot scheme, the first stage of work is, putting down of several 12 inch diameter wells around the quarrying area. Such wells have been sunk on the three sides of the proposed quarry, leaving the western side open. The water issuing out of these wells, artesian in character, are arranged to be coursed for proper utilisation through suitable irrigation channels. The next stage of work is the acheiving of fall in the piezomatic level by use of high capacity deep well or submersible pumps inside each artesian well. The capacities of these will exceed that of water in the bore holes. It is proposed to use in the bore holes perforated casing pipes at the bottom filled to a certain height with pebbles to prevent the collapse of the boreholes due to the inrush of sand being drawn in, while pumping.

The quarrying will start simultaneously for the following purposes namely, to recover the high alumina clays, (2) to extract the lignite (3) to drain the artesian aquifers and (4) to furnish a large quantity of irrigation water.

The first two objectives are to be acheived by the use of high capacity submersible pumps in the boreholes made for releasing the artesian aquifers and by well point system of pumping. After acheiving this the artesian aquifer is to be ripped open and all the pumps withdrawn and the quarry allowed to be filled up and overflow under natural discharge through proper channels.

With a view to stop the charging of the aquifers from the recharged area over again, holes have been sunk on the three sides of the quarry. Into these collodial clay is to be injected. An invisible screen wall is thus proposed to be formed. As the flow is expected to move from north to south further charging of these aquifers must get arrested by the erection of this wall. It will thus be possible to drain out the artesian completely by using turbine and other pumps. As the sea is again far away and as geological peculiarities alone cause the artesian conditions it is quite likely that the sea water may not find its way into the quarry. By proper sluices or levelling of the channels the pumped out water is proposed to be prevented from getting back into the quarry.

With electricity laid all round the quarry, work goes on all through, in 3 shifts each day. An area of

600 ft. × 600 ft. is selected for quarrying. This is to be stepped with each step 30 ft. wide and 20 ft. high and with 9 such steps on all the four sides. A depth of about 180 ft., that is to where lignite occurs, is thus proposed to be reached. News is to hand, that Mr. Ghose has evolved a working by which, he has dispensed with a number of steps. He is taking into the earth, a sort of a tunnel like passage, round the quarry, from top to bottom, in which the machineries will work, excavation proceeding on the top all the while. After the thinning down of the top sufficiently, it will be blasted, the tunnels being used as open roads. The verticals, erected for this purpose, though sloped a little are known to stand. The method is not only economical but a great time saver.

In the first stage cutting loaders, euclid dippers operating along with bull dozers and conveyors, work to remove the earth. Toornapools operate alongside in excavation. Bull dozers and Caterpillar tractors are expected to lend assistance.

These will prepare the way for the operation of shovels which in addition with slight alterations by the changing of the boom are expected to be used as walking draglines.

The well point system pumps will be used in stages of about 20 ft. as and when necessary to predrain the area along the steps. The debris at present are being carried in dippers, and dumped a little way off. If

necessary the debris will be dumped into hopper bins fed by a conveyor from the quarry. Another conveyor placed below the hopper bin will deliver to inclined conveyor mobile or adjustable for dumping the excavated material. The dump would be spread out by bull dozers to enable the conveyor to function as a stationary conveyor.

About 100 sq. ft. of surface underneath with a depth of about 80 ft. of lignite is expected to be opened out thus by quarrying.

The rate of excavation it is estimated will be comparitively cheaper than charges incurred in using human labour for excavating, besides saving considerably time, which is the essence of work.

After the working of the pilot scheme regular mining is to commence. Very likely this may be a development of the pilot project in the light of experiences had.

The scheme though intended to help the development of a portion of the lignite bed can also turn out a major irrigation project, which can be combined to generate sufficient hydroelectric power.

The scheme is

(1) Opening up (at a suitable site on the southern side of the Cuddalore - Vridachalam road) of a number of contiguous deep tanks (quarries) of sufficiently large size to yield a continuous supply of water (from artesian sources) for the channels and conduits to be built for the purpose of generation of hydrel power and irrigation.

(2) The excavated earth to form the embankments of the reservoir which will furnish additional head for generation of hydro-electric power.

(3) The water from the reservoir to be conveyed by flow channels and or pipes to the lowest point on the cantour and the head taken advantage of to generate hydrel power.

(4) The water released before and after generation of power is to be used for irrigation purposes.

Messers R. E Louis and H. Davis, Mining Experts of the U. K. Powell Duffering & Co., under the Colombo Plan of Technical Assistance have recently completed a study of the mines and blue prints for full scale commercial exploitation are getting ready. A number of specialists will shortly work to prepare plans on different aspects of mining.

Fuel Problems of the South

As the South is fuel starved, about 1·5 million tons of coal are at present being got from the North annually. Out of this 4,40,184 tons of all grades of coal arrive by rail and 10,74,810 tons are brought by sea cum rail.

The State for the flue curing industries need about 2,71,800 tons whereas other industries demand 1,11,320 tons. About 30,800 tons of slack coal are needed for brick burning. Foundries utilise 12,024 tons of hard coke.

The principal consumers of coal are the Paper Mills who annually use about 4500 tons. The cement factories take about 18000 tons. Open hearth gas producers use 72775 tons. Rolling mills need nearly 5475 tons and the requirements of the refractory plants are about 4500 tons. The Tramways used to take about 4500 tons.

The coal at present comes from a distance of nearly 1000 miles from Bengal and Bihar in the north. Owing to the long haulage, it does not pay to send down here lower grades of coal. The railways carry the burden of transporting the coal and in so doing they consume a good portion of this load themselves with the result when ultimately coal is handed to us, it is loaded with heavy freight charges and the price of coal works out 3 times its prices at pitheads and sometimes four times even in some parts of this State.

The industrialists are quite prepared and willing to pay these soaring prices if only they could be assured

regularity of supplies and their requirements. Such then is the desperate need for coal in these parts. In view of these almost prohibitive prices and in view of the non availability of solid fuel and with a view to effect a much needed saving on waggon, loco power, traction capacity and relieve the railways for other and more important nation building activities, alternate arrangements have to be made for assuring ourselves of our fuel needs.

It is true, with great foresight, concentration is being made on hydrel power in this state. This is comparitively the most advanced State in this line and we are far ahead of others in India. Pykara at present has an installed capacity of 48430 KVA and Moyar is another 63000 KVA proposed. Mettur's capacity is about 50000 KVA. Papanasam now has 21750 KVA and is getting ready to be improved by another 19000 KVA. The ultimate development of Machkund is estimated at 100000 KW. Besides about 4000 KW are being purchased from Jog Falls.

Probably those in the Scandinavian countries and Switzerland are the only people in the world to depend entirely on hydrel power for all their needs. The natural advantages with mountains and rainfall find for them a perrineal supply of water for generation of power all through.

Here this installed capacity is not capable of meeting all the needs of the State. Besides, this hydrel system depends for its success on rainfall. The vagaries

of monsoon and the succession of droughts during the last 6 years or so, had exposed the limitations. It is estimated that owing to the power cut the loss to industries is enormous and during last year we had one of the heaviest cuts in power imposed on us.

With a view to assure continuity of supply in some places it has become necessary to build thermal stations. We have the largest of such stations in Madras, generating nearly 45000 KW which is further proposed to be enlarged to 100000 KW. Madura Vizayawada and Vizagapatam are other stations generating power by steam and their total output is nearly 25000 KW. A small percentage is generated in Kakinada and Kurnool by oil and this is about 1000 KW. There are besides 75 licensees and their estimated production is about 2% of the whole output.

The industrial rates vary from ·58 annas per unit for small consumers to ·3 annas per unit for large consumers.

The working of the thermal stations need fuel. So in both cases for generation of power dependance is on another which is problematic or non existant. Our fuel needs continue and remain unanswered.

The possibilities of winning the South Arcot lignite are keenly looked forward to. The availability of this lignite should not only meet all the requirements of the south but also leave a very good part for export and should effect considerable saving of money in the matter of freight, besides saving the railway for other and more important obligations. In Australia a very big thermal

power station which is over 41000 KW is producing about 1,503,000.000 KW hours by the use of lignite of the mines in Yallourn in the State of Victoria. It is said that before war Germany produced 41% of her power requirements from lignite by direct use in suitable boilers.

In the matter of domestic fuel, it is computed that taking 1951 census, and assuming that each adult uses ·0178 gundu (1 gundu is 56 lbs.) and about half the population use fire wood, the estimated requirements will be 7,519,000 tons of firewood. Calculating the urban population's need of charcoal at 1 maund for a family of five, about 1,65,339 tons of charcoal will be the need. 3½ to 4 tons of wood are needed to make 1 ton of charcoal. It is understood that about 2000 tons of soft coke are being got from the north to meet the requirements of the hotels and other domestic purposes. This heat value of wood is 5 to 6 thousand B Th U and that of charcoal 10 to 11000 B Th U.

The type of wood mostly used in Madras and some other places is casurina. When the tree is in the minimum about 6 to 7 years old, it is usually cut and fresh plantations are possible to replace those cut. This intervening period being large, a very large area has to be kept in plantation to assure a regularity of supply. In most places other types of wood, commonly known as jungle wood, is being used. These are from very old trees and must be so, to yield a good tonnage. When once they are cut, it will hardly be possible to replace them even in the course of some

decades. With the growing population and the growing demand, these trees are cut indiscriminately and even forest areas are getting destroyed. The awful deforestation had been so high that it had hardly been possible to replenish them. A famine had therefore set in and although it is now in its initial stage only, the strain is already felt. The prices of firewood in retail at Madras is Rs. 70/- per ton and that of charcoal about Rs. 200/- and is higher in some places. The State is faced with a crisis of magnitude and is in the grip of a famine. Inspite of the very commendable objects of Vanamahotsava, there seems no prospects of tiding over the immediate difficulties. The scheme is long ranged and will not answer the immediate needs.

In rural parts, cowdung cakes are used extensively as fuel. This is a collosal waste of very valuable manure. Such use and consequent waste, although difficult to assess actually, is certainly of a very big magnitude. Suffice it is to say that more of animal waste goes as poor man's fuel than as manure.

All eyes are therefore necessarily turned to Neiveli. When the lignite is briquetted and carbonised, the fuel problem is bound to be solved. Although only the pilot project is being worked just now, a thermal station and a briquetting plant are certain to be installed simulteneously with the mining. Blue prints, arrangements etc., are almost ready. If lignite is mined at all it is certain the lignite is going to be utilised for generation of power and the carbonised briquette should fill every domestic oven and industrial furnace in this area.

It is hoped power to industries in adjacent area should be available at ¼ anna per unit and the briquettes should be available to the public at prices comparitively cheaper than charcoal. This will, it is hoped revolutionise the fuel position of the south.

Neiveli is admirably situated. It occupies a very centrally located position amongst some of the important towns of the State of Madras. When production of town gas, by heating the lignite is taken up, urban areas like Madras, Tiruchi, Salem, Vellore, Tanjore, Chittor, Cuddalore, Pondicherri, Villupuram, Tindivanam and Chidambaram are likely to be served with town gas. This kind of fuel is bound to be popular with the urban population and the cost of this must be very competitive. These towns are located within a radius of 150 miles from Neiveli and can therefore be easily fed. It is known that conveyance of town gas in 3 ft. diameter pipes over a distance of 150 miles, work out cheaper than transmitting electricity over the same distance.

There are no oil wells in the south and consequently we have to depend on imports for our oil needs. Germany too, similarly placed to offset her wartime shortage of petroleum, developed synthetic extraction of petroleum from coal. This process is known as Bergius-WG Process. The principal difference between oil and coal is, the oil contains more hydrogen ions. The German process formed liquid fuels by adding hydrogen to coal, accomplishing the addition by suspending fine particles of coal in an oil and treating this mixture with

hydrogen gas under very high pressures and at high temperatures. This is of course a complicated process.

The chemists of the US Bureau of Mines have evolved a new technique by which hydrogenation of coal can be effected without suspending the coal particles in oil. This consequently eliminates the need of equipment for preparing the oil initially in the process and for seperating the oil from the resulting mixture. The space formerly occupied by the oil as well becomes available for the conversion of more coal.

Hydrogenation is accomplished in the new process by blowing hydrogen gas up through a bed of coal particles at such a scale that the coal particles 'dance about in a manner closely resembling that of a boiling fluid.' Such a technique commonly described in industry as 'fluidized technique' permits the chemical addition of hydrogen to coal at much lower pressures than those demanded by the Bergius process.

It is said that gasoline can be produced from lignite at costs ranging from 9 to 12 annas per gallon. The plant investment is calculated between 30 to 35000 of rupees for each barrel capacity per day for plants of 10000 and more barrels capacity. This 30 crore affair is far beyond the capacities of the State at present and it is not likely to be taken up at once, inspite of the very alluring promises it holds.

Looking on all sides and taking everything into consideration, the one and only hope that holds before us for the solving of our fuel problem, is the outcome, of the lignite mining in South Arcot District, Madras State,

Mineral Map of the South and Industrial Possibilities

We are half way through in our national planning and yet we are far away from the objective. People have gained a new consciousness in the national reconstruction that is going on. In our economy the accepted opinion is that the prosperity of the masses can only depend on agriculture. But this view cannot be used as an argument against industrialisation. No modern State believes that prosperity can be achieved without industrialisation. This State, as a matter of fact this country, is justified in giving top priority to agriculture rather than dabble on possibilities of doubtful ventures. But still, a sound industrial policy is necessary.

The State of Madras is very peculiarly placed. It is fuel and water starved. Agriculture in these parts depends to a large extent on the monsoons. In some places, the waters of the few rivers have been harnessed by construction of dams and more and more acres are being brought under cultivation. To meet the fuel deficit, the State concentrated on building hydrel power, wherever possible. But this, as well, is dependant on the vagaries of the monsoon and many therefore have been the limitations to the growth of industries.

Inspite of these handicaps and natural disadvantages the State has made some progress. The State has on its rolls over 2 millions of workers which total is larger than that of any other State. This is the only

State having a ship building industry and nearly 4000 men are employed in the Scindia Steamship Navigation Co., Ltd. The State has 7 sugar factories and the rated capacity is 88000 tons and and the plant in Nellikuppam is the largest in the East. An addition of another 60000 tons are proposed to be added. Textiles occupy a very inportant place in the State's industry. There are about 172 factories the largest of the establishments, The Buckingham & Carnatic Mills employing 15450 persons. With the availability of hydrel power in the cotton growing areas large number of spinning mills have sprung up in the south and the output is nearly 5,00,000 bales which is about 1/6 of the country's production. Three major factories in this area out of the 13 in all engaged in the manufacture of cement, lime and potteries, produce nearly 1/3 of the country's output of cement. Tanning is another large scale industry and 280 factories are engaged in this trade. Along with Uttar Pradesh this State almost has a monopoly in this line. There are many small scale industries and 124 factories located in the south of Madras produce nearly a third of the country's output, namely 8 millions of match-boxes.

The neighbouring State of Mysore has always held advanced views on industrialisation. T C State is fast falling in line. Hyderabad has raw products.

In our country as is only to be expected the key industry, is iron and steel, and this is confined to areas in the north where high grade coking coal is produced. In the absence of coal fields in the south, the area is

backward industrially. It is now known that lignite can be substituted for coking coal in the direct reduction process for production of iron and steel from iron ore. When this substitution is effected, the location of the industry is certain to be altered and fixed in this State. With the striking of lignite in Neiveli, the State is in a very enviable position. It is understood the Union is negotiating with a German firm for starting a steel factory and arrangements are almost completed. Another factory is in the offing and the outcome of the lignite mining is awaited for location of the next plant.

Salem is endowed in plenty with nature's bounty. The iron ore available in this area lies in close proximity to the lignite fields and the future is bright for industrial development. Iron and steel occupy a proud place in the industrial world. But in recent times, aluminium is fast replacing steel and iron in many lines of industry. The building of aeroplanes etc., out of aluminium has thrown new light into the future of aluminium industry. In Yercaud, next to Salem town, there is a rich field of bauxite. This is rich in quality as well and should cost comparitively less in processing. Supply of power and or fuel is keenly awaited for the development of this product and much is going to depend on the outcome of the lignite mines.

The State is therefore doubly assured with iron, steel and aluminium and a plentiful supply of fuel, all lying in very close proximity to one another and tremendous therefore are the possibilities of the industrial future of this State.

One naturally would like to be assured about the fuel position in the first place. There is an adequate quantity available, good enough to last for hundreds of years and it has been proved by extensive borehole operations. The quality of lignite is guaranteed by reports from the reputed laboratories of the world and the Fuel Research Station of India. The German (Lurgis) experiments on our lignite and iron have yielded excellent results in the matter of metallurgical coke. The proportion of overburden clays to lignite is 3 : 1 ratio and an economic mining is a certainity.

Inspite of all these, there seems to be some doubts expressed on the outcome of this lignite mining. It is true, the lignite is sandwitched between two layers of pressure waters. The winning of the lignite therefore is not easy picking.

Pressure waters flood the excavations. They have to be effectively kept out. Doubts are entertained on account of these waters. In this age, keeping away the water is not an insuperable difficulty. Sea dykes, dams and ports are built only by keeping away the waters. The problem is merely getting suitable machineries. Earth moving and excavating machineries are needed in the first instance to go to the bed of the lignite. And when the last layer is reached at a depth of 150 ft., the pressure waters have to be removed by pumping out. Can machineries remove the earth economically? Can well point and other systems of pumps effectively deal with pressure waters? The answers are, yes.

The real problem therefore is something else. A project of this kind even in the investigation stages consume very large amounts. Any mining project needs very large outlay. With the presence of pressure waters, it has become necessary to find still larger sums for suitable machineries.

The State is in a difficult way financially. The resources are very slender. Even these resources have been tried very sorely in recent times by the successive famines, droughts and floods. The five year plan handed to the State finds itself committed to large expenditure. And now has come the seperation of the State of Andhra. The State is hard put to meeting many obligations.

In this background the go slow policy of the Government can best be understood and appreciated, although it is true, in a matter of this kind delay by a few months may mean a loss of a few lakhs which the State can hardly afford.

Inspite of this unenviable position, the State has been expending large amounts on this venture from 1947 onwards. Nearly 37 lakhs of rupees had so far been spent on capital outlay and preliminary investigation. The State was bold enough to commit to expend another sum of rupees forty lakhs for machineries etc., in working out the pilot project. Nearly 30 lakhs out of this is so far saved to the State by the loan of machineries by the Union Government from out of their disposals dump. As these machineries are war worn, a large

maintainance establishment is necessary to keep the operational units in order and to work economically and effectively. The State is put to the necessity of finding this cash expediously.

The Union Government by its recent agreement with the U.S.A. has secured 11 lakhs of rupees which will go to buy excavating and earth moving machineries. The mines are also equipped with a first class laboratory, the nucles for which was contributed by U.S.A. A sum of 35 lakhs is earmarked by the Union Government which should relieve considerably the financial strain that has been retarding the progress.

It may not be out of place here to appreciate that now or never should the State go all out to determine the possibilities of this venture by speeding up the pilot project Even taking the extreme view, should this prove a flop, it is rather better the State knows where it stands and starts afresh to plan its future. If on the other hand this proves a success as it is hoped it will, immense are the possibilities and thc State can go about confidently in planning the future. The State is now on the brink of taking a very momentous decision.

The problem of finances having been resolved thus it may just as well be necessary to take stock of conditions in the south. The adjacent district of Salem is known to contain manganese, magnesite, bauxite, Chromium, mica etc. For long we have known the gold fields of Kolar. It is said that these fields are getting

exhausted. But to the north west of this area are other fields prospected and proved for gold. Sandur has a rich quality of steel, easily the best of ores. Travancore area is rich in ilmenite and monazite. Near about the west coast pyrites, copper, chromium and potash salts are available. The Andhra area is rich in byril, asbestos, and mica and small industries are already working. Banganapalle has some precious stones. Thus it is seen that the south is minerally very rich. Good fuel alone had stood in the way of development in the past.

Neiveli, the fuel station, is most strategically placed. It is within a reasonable distance of most towns of the State. It is connected by rail with Salem. Cuddalore port is only 25 miles. Salem has both meter and broad guage railway lines. By locating the industries suitably, all the natural advantages can be availed of and the transport problem solved. Visions of large and vast stretches of steel road loom large between Cuddalore and Salem, the railway lines getting doubled and trebled. Small hamlets are already buzzing with activity.

Industry and foreign trade are closely linked up together. The days are gone when we were exporting rich raw products for want of facilities. We are now assured of self sufficiency in our vital needs. And now we look forward to a sizable export.

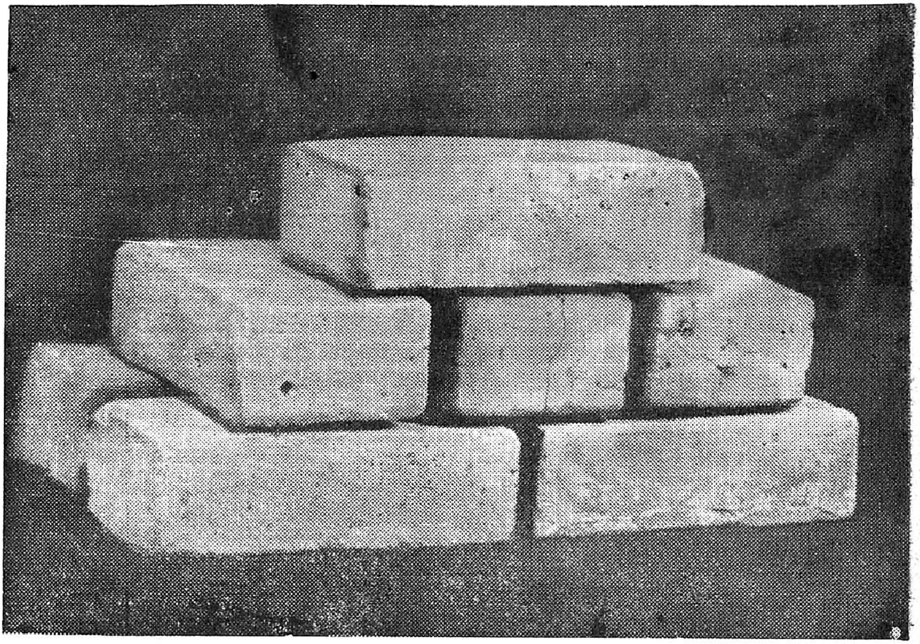
The Possibilities of Private Enterprises

With the mining of lignite it has become necessary to examine the possibilities of several industries that may usefully be started in the south. Two South Indian firms of standing recently applied to the Government for mining concessions. There were some approaches by foreign firms as well to put up large scale enterprises in this area.

It is almost certain that the State would itself undertake the mining. It may also build a Thermal station for generation of power. It is also certain that a carbonised briquetting plant is likely to be installed. The State may also generate, town or water gas. Production of synthetic fuel is another venture of a colossal magnitude and may fall to the lot of the Government. These are huge ventures, which the State Government may do by itself or work in collaboration with the Union.

One may wonder what then would be left to private enterprises. Very few realise that innumerable are the lines that offer themselves. The development of any or all of these are necessary for the ultimate prosperity of the State. The State certainly has limitations to the number of lines it can handle. Private enterprises are bound to come in.

The overburden clays which have to be taken out, offer themselves for use. The top clays are found to be good in the use of brick making. Bricks are burnt all



FIRE BRICKS MADE OF NEIVELI CLAYS

POTTERIES

over in country klins or by chamber firing. Slack coal is commonly used, though in most country klins fire-wood is also being used. In Palana, Bikanir, lignite is preferred to slack coal because of the low heat value and uniform rate of burning. Invariably the cost of brick goes up considerably because of the transport charges of getting raw materials and taking the finished product to the consumer. The need for bricks is universal. In the Neiveli area, the prices of bricks at present are very high, inspite of Neiveli having the clays, lignite and water, and with skilled labour also being available in the neighbourhood. In view of the certainity of the area being built up in the near future, it may as well be worth while if a few enterprises start forthwith in this area and the State may induce the starting of such enterprises by offering to take the bricks for its use.

The manufacture of tiles is almost the monopoly of S. Kanara with 44 factories, the rest of the Districts except for Malabar and Godavari have negligible number of factories. In view of the location of the tile factories in the west coast area alone, need for starting brick and tile factories in other parts of the State particularly in and around lignite area where natural facilities abound can best be understood and appreciated.

We have already observed that the alumina content in the clays vary from 30 to 65 per cent and from a depth of 60 ft. or so the soil is declared to be good for refractory and other purposes. Standard bricks normally need 35% alumina. Bricks made out of

this clay on tests at temparature of 1400 dg. C. are found to withstand the load test of 800 psi. For heavy jobs like bridge building these bricks should be in demand. There are immense possibilities for the starting of an enterprise for the manufacture of hume pipes.

In U.S.A. a process is developed by which alumina is extracted from china clays. As there is demand for alumina, an independent factory is desirable. Small factories for brick and tile making, refractory and other purposes, and manufacture of china wares can be located near about to advantage.

Dalmiapuram in the neighbourhood specialises in refractories and cement produces. Lime stone of good quality is available. The lignite will go to aid the present industries and also help in the starting of new ones. Manufacture of abrasives is already a profitable line handled in Dalmiapuram from out of the clays.

There are 6 glass factories in the State out of which 3 are fairly large. Such big factories are confined to Madras and Salem alone. As the use of lignite is preferred in the manufacture of glass and as there is considerable scope for development of this line useful industries can spring up in this area.

Sulphuric acid is another necessary product in our economy. Lignite is used for recovery of sulphur from gypsum. It is known that in Tiruchi the best quality of gypsum is available. A plant for the manufacture of sulphuric acid cannot be an excess and in fact it will answer a dire need.

Montan wax or ester wax is a very useful product. During the war large quantities were utilised in making phlegmatics and in peace time it serves very many useful fields. The usefulness of the product is such that nearly a depth of 600 ft. is gone into in UK to extract this wax from a lignite bed of 6 ft. yielding 10% wax. The available lignite in these parts are woody and peaty yielding a high percentage of wax. This line should prove necessary and profitable and a plant can therefore be installed for this purpose.

We are at present importing large quantities of activated carbon the prices of which range between Rs, 1000 and 1500 per ton. Our requirements can be met in total and at competitive rates by the installation of a plant.

Manufacture of plastics is another useful line for consideration. These brown coals with high lignin content can be moulded into for plastics. It is estimated the coal plastics cost about 1/10 of bakelite.

Lignite can yield tar which in turn can be worked into various fuels and carbolic acid extracted by different methods. From carbolic acid cresols and phenols can be obtained. A plant for making of disinfectants can be considered.

By chlorinating tanning materials can be made. As the State is largely employed in tanning, an industry for the manufacture of tanning materials will go a long way to help an established industry.

Fractional distillation may yield toluene, saccharine and napthelene.

Immense again are the possibilities of making medicines and in this, sulphanamide group of preparations offer themselves.

The stage is thus set for very many industries big and small. As the State is likely to have its hand full in major ventures, opportunities offer themselves for growth of private enterprises in very many lines. These varied and useful lines, big and small, should go a long way to fill in our essential needs.

There are natural facilities for the growth and development of these industries. In addition to the raw products, power, fuel, water, transport, other facilities like accomodation and labour are available in plenty. For most of these items of manufacture an internal market is already assured, as we are at present depending on exports. This in the first place will go towards the objective of meeting the self sufficiency. An export of some of these products is a distinct possibility. Investments may vary from a few thousands to some millions dependent on the nature and type of industry proposed. Even small industries will prove a necessity.

The State is not opposed to the growth of private enterprises at all. It is considered that until the pilot project establishes a proper method for estimate and a correct value of lignite it may not be fair to the State or to private enterprises to entertain any large scale

committments. This then is the expressed view regarding policy on issuing mining concession.

There is every reason to believe that the State may welcome the development and growth of industries on the lines suggested on first thoughts herein. As progress is made many opportunities may unfurl themselves. A start can even now be made in some lines. Here then is something for private enterprises to think about.

The Use of Lignite in High Pressure Industrial Boilers

Everybody knows that coal is used in Boiler furnaces to generate steam but coal is not found in all parts of the world. Hence in those parts of the world where coal is not available economically anything that is combustible is used to generate steam in Boilers and Lignite or Brown Coal is one of them.

No coal has yet been found in South India beyond the Singereni coal field in the Hydrabad State and though enough coal is available from the Bengal and Bihar coal fields yet this cannot be sent in sufficient quantities to the South due to transport difficulties. We have, therefore, to seek for some other substitute for reasons of economy and the industrial development of the State.

The find of Lignite in the South Arcot District of the Madras State is therefore of great consequence. The Government have taken up the initiation of the development of a project which, will, when fully developed contribute substantially to the industrial progress and prosperity of the State.

The Project was inaugurated on 5th March 1953 and is now under progress with excavating machinery lent by the Union Government.

With the data obtained on the completion of the Pilot Quarrying Project two problems will have to be solved. They are :

1. How to mine the lignite economically and safely,
2. How to use the lignite economically and efficiently.

To mine South Arcot lignite economically two things are essential. Firstly arrangements have to be made for mining a minimum quantity of a million tons a year and secondly arrangements have to be made to consume this quantity. For the first, large size modern excavators and conveyors and other suitable machinery and equipment have to be employed. And for the second a sufficiently large outlet has to be found to use the lignite as mined.

The installation of additional large capacity Thermal Power Station near the mines is necessary to partly meet the second contingency. Because of its inherent qualities, Lignite cannot be used as mined to any large extent, in the existing boiler furnaces. To use lignite in any quantity the Thermal station has to be provided with boilers having a furnace designed for burning South Arcot lignite.

Now coming to the question of use of lignite or brown coal in boiler furnaces, it must be remembered that lignites all over the world contain a very high percentage of moisture and is of woody structure and South Arcot lignite is no exception to it. Below is given typical analysis of German, Australian and South Arcot lignite. The difficulties involved in the direct use of a fuel with chemical and physical characteristics as these can be readily imagined.

Contents	German	Australian	South Arcot on dry basis.
Moisture -	59.00	65.23	15.08
Ash -	2.40	0.69	3.20
Volatiles -	21.20	17.68	44.78
Fixed Carbon	17.40	16.43	36.94
Phosphorous -	Percentage not known	not known	traces
Sulphur -	Percentage not known	not known	1.15
Calorific Value			
(B. Th. U/lb) Wet	4,450	3,780	4,500
Dry	11,000	19,870	11,000

The South Arcot lignite as mined contains about 40 to 50% of moisture. With this moisture it cannot be fired usefully unless dried to generate steam. Further due to its woody structure the lignite breaks up on losing the moisture and drops through the furnace grates, if the grates are not specially designed to burn this type of coal (fuel).

Certain tests were carried out by Sri A. R. Narayana Rao Superintending Engineer (Generation) with South Arcot lignite at the Basin Bridge Power Station in one of the existing boilers, the furnace of which had a chain grate suitable for the purpose. The test indicated that lignite can be used on this furnace by controlling the grate speed and by furnishing copious supply of air both under feed and over feed. The problem of ignition was, however, found to be difficult and various methods were

tried to achieve initial ignition. The experiment indicated that for efficient burning the lignite should not contain more than 10 to 15% moisture that is, it should be dried before it is used on this furnace.

Lignite has been mined and used extensively in many countries of the world. During the early part of the century, lignite fired boilers were used in Germany and Australia with ste-grate furnaces. Developments followed with improvements on the existing furnaces and the development of new types. Though hand fired boilers are also used in certain areas with certain modifications of grate and draught, yet it is considered that either the chain-grate stoker with suitable grate and draught arrangements or its counterpart the spreader stoker could be more usefully employed to burn lignite or brown coal efficiently.

In either case however, the fuel must be pre-dried to a moisture of not more than 12%.

The greatest difficulty in burning brown coal on standard type stokers is to obtain initial ignition. This problem has to a certain extent been met by the modification of pre-ignition grates. Before a piece of coal can be ignited it must have its surface dried and the dried portion heated to ignition temperature. Even disregarding the subsequent remission of volatile hydro-carbon it is clear that a large amount of heat is necessary for complete ignition.

Pre-ignition can be instituted by the use of a combination of black and brown coal. The slack coal particles

ignite more easily and provide ignition of the moist lignite. Auxiliary oil ignition has been widely used. It has the disadvantage of high cost, since the amount of oil required is large.

There are two methods of pre-ignition adopted, that is underfire and over-fire.

Due to the ignition and other difficulties and bulk of opinion in the countries using large quantities of brown coal like Germany, U.S.A., Australia, they are now swinging towards the use of pulverised fuel firing of high pressure boilers.

Pulverising is done by various types of pressures with a combination of driers. In Germany, Krammer type mill is very much popular. In this pulveriser or mill, the undried raw brown coal is fed to the pulveriser together with preheated air so that coal is both dried and pulverised at the same time. Power consumption for this is stated to be about KWs per ton of input. The mills have a capacity of about 12 metric tons of coal an hour each.

Mills of this capacity are usually worked by a hundred KW motor drives, each with about 600 RPM. The mills or pulverisers have hammer with replaceble wear blocks.

The number of pulverisers or mills vary with the capacity of the boilers. 2, 3 or 4 mills are often used. In boilers used in some of the countries, only front firing is used as in the Bokhare Power Station. In German boilers however corner firing is generally used. Informa-

tion is available about these power stations in Rhineland where mill firing of brown coal is extensively used. There are two at Vereighe mills and one at Verreurath. At Vereighe there are 4 boilers each of 290,000 lbs of steam per hour capacity at 1500 lbs sq. inch pressure and 932°F. Each boiler has 4 pulverising mills one in each corner. The boilers are all similar but are made by 3 different companies as detailed below :

	Boiler Makers	Makers of Firing Plant
Boiler No. 1 & 2	Vereineghe Ville	Kesselwerks Krammer
3	Badcock	Badcock
4	Waltheswerke	Franckle Viebahn

The heating surface of each boiler is 5900 sq. ft., and that of the two stage superheater is 4500 sq. ft. Each set has a three section economiser, 9 Ljingstrom air pre-heater and a Lurgi Siemens Cotterrel fly ash precipitator. Both forced and induced draught are used and all operations of the boiler plant are completely mechanised.

It is stated that although each boiler has four mills these will easily satisfy its fuel requirements and even 2 will just suffiice if pairs of mills in opposite corner are used to fire the boiler.

Though pulverised fuel firing of boilers has been in the forefront of the German industry and of the many

other industrially advanced countries, yet as regards high moisture brown coals it is considered, that it would be worth while to use charred lignite instead of raw lignite in high pressure boilers. In any case, the waste heat of the flue gases could be utilised to do this and that it will mean a lot of economy and plant efficiency.

A process for utilising the vast lignite and sub-bituminous coal reserves of the American west as a source of cheap electric power and coal tar products is described in detail for the first time in a Bureau of Mines report just released.

Based on the Bureau's experiment the Texas Power & Light Co., is building a Central Electric Power plant in Milam county in Texas, that can use Texas lignite and also provide for Alcoa's new aluminium smelting plant opened in December 1952. Fuel derived by this process is expected to compete with natural gas at prevailing prices It will be a year however, before the Alcoa plant begins drawing on the new power source.

Known as coal carbonisation in a fluidized state the process represents two years of research by the Bureau of Mines in cooperation with Texas Power & Light Co. Experiments were carried out at the Bureau's pilot plant in Denver.

The major object of the Bureau's investigation, conducted from 1949 to 1950, was to develop a technology for carbonising lower rank western coals, so that valuable tar, the source of many basic chemicals, could be seperated from their residue. The charred

residue however, acts as the boiler fuel, that can be used eventually to produce thermal electric power.

As a result of the Bureau's process a new horizon has been opened, making lignite and sub-bituminous coal commercially promising on a large scale. Often called " Fluidized Carbonisation " the new process is a variation of low temperature carbonisation and yields a char of high heating value for power plant use and crude primary coal-tar. It is also a possible future source of bye products such as drugs, dyes, plastics and explosives-products which come from coke oven tar now.

Fluidized or entrained drying is merely a process of mixing fine coal with hot gases in such proportion that the resultant mixture reached a temperature of 275 or 325°F. After the coal is in this environment long enough, 90 to 95% of the inherent moisture is evaporated. This takes approximately 50 seconds. The velocity of the gas and the size of the drying chamber are other important features in drying.

To carry out the research, the Bureau developed two pilot plants in Denver, one of 5 tons capacity per day and a larger intergrated unit of 25 tons a day, where the drying and carbonising operations are run in sequence. The commercial power plant now being built in Texas will use about 100 tons of lignite a day, in each of nine units, comprising the lignite processing part of that plant.

(Paper read by Sri H. K. Ghose at the Engineers' Conference at Dalmiapuram on 30–8–53.)

Manufacture of Pig Iron from Salem Iron ore with South Arcot Lignite

The potential strength of a country depends mainly on its mineral oil and mineral resources. Of these motor fuel, iron and coal play an important role in the political, economic and industrial life of a country. Excepting for a small petroleum deposit in Assam, oil is not known to occur in India. India possesses vast resources of iron ore of both high and low grades. All industrially developed countries with the exception of Germany have good iron ore deposits either within or easily available to them. South India possesses the largest deposits of low grade iron ore in the country extending over Tiruchi and Salem Districts.

India has large reserves of coal, surveyed and otherwise. The reserves of her metallurgical coal are so depleted that they are quite insufficient even to smelt a fourth of the known iron ore reserves. This is not the only country facing the shortage of coking coal. The supply position over all the iron producing countries is gloomy. This has resulted in extensive researches being made on three different lines namely, (1) to supplement the supply of metallurgical hard coke by adopting means of conservation of coking coals ; (2) by washing and blending non-coking coals with coking coal ; (3) to find a suitable substitute from non-coking coals, by a petro-graphic study of their constituents and (4) metallurgical carbonisation methods.

TAMIL NADU ARCHIVES LIBRARY
398
ACC. No
EGMORE, MADRAS-600 008

South India is not blessed with a deposit of metallurgical fuel or even with a deposit of bituminous coal. The recently found lignite is expected to compensate her want of coking coal and in this regard her resources of coal and iron are comparable to conditions in Germany. Like South India, Germany is dependent on the extensive lignite deposits of Ruhr Sarre region and upper Silesia. Germany also has extensive coal deposits, having low iron content similar to the Salem ore. Before and after the first world wars, Germany was using foreign ore mostly from Sweden of high iron content. But during the wars it became necessary for her to depend only on her own resources. The Lorrain Minette played an important part in the German iron ore supply.

In 1935 a big Iron and Steel works was started in Salszitter in Germany, which was designed to work on a new German process by which good quality pig iron could be obtained from ore with high silica content. These works smelted low grade iron ore in their furnaces and became independent of foreign import, inspite of the advantages the foreign ore offered with their high iron content. The Lorrain Minette contains only 35% iron. Salem averages over 40%. The Germans are not known to subject their ore to extensive pre-treatment for enriching the quality. A large part of German ore is of a soft and powdery nature with a strong tendency to disintegrate. Extensive trials with the metallurgical coking process have proved that inspite of the handicap of relatively high silica content the

German ore, with a low iron content can be smelted at a fair rate of output in low shaft furnaces. It has further been proved that the new process is capable of treating both lumpy ore and briquetted fine ore at the same time.

From a comparative study of the German practices and a study of the report of the analysis on Salem deposits, it seems that the ore can be enriched sufficiently, after crushing to a suitable degree of fineness by gravity seperation process either dry or wet only. It may not be necessary to subject the crushed ore to further magnetic concentration. It remains to be seen whether it would be economical to smelt the lumpy quartsite-schist with over 40% iron content directly in low shaft furnaces as is being done in Germany, instead of crushing them for enriching either by gravity seperation process or by magnetic concentration method, or both.

In the State of Ohio in U.S.A., a process is developed for concentration of low grade iron ore. In the Mesabi region, in Minnesota the high quality iron ore are getting exhausted in supplies. Attention is therefore diverted to the low grade magnetic toconites. Experimental results go to show that it is practicable to produce commercially high quality iron pellets from low grade toconites. Three tons of magnetic toconite rocks are reduced to one ton of walnut size iron pellets containing 63 to 65% iron. The ore as received pass through a series of dry crushing and wet grinding processes which so pulverises the ore that the iron particles can be drawn out magnetically leaving behind silicious matter in the tailing sludge. The iron particles thus obtained

by magnetic seperation is subjected to rolling into walnut size pellets which are then baked for hardening. The cost of such production is not comparatively costlier.

Metallurgical upgrading of small grained iron ore—Metallurgical carbonisation

The small grained and powdery ore presented a problem to the blast furnaces. By this new technique of upgrading of small grained iron ore combined with metallurgical carbonisation of non-coking coal, the problem is practically solved. It has been proved in Germany that suitable metallurgical coke for the smelting of iron ore can be manufactured even from semi coking and non-coking coals. The process of manufacturing, shaped coke from semi coking and non coking coals, is accomplished through the Two stage carbonisation process. It is hoped it may not be necessary to subject the Salem iron ore after concentration to pellet rolling. It should be possible to use the concentrated ore in conjunction with South Arcot lignite to form composite briquette for metallurgical carbonisation to yield useful bye products and liquid pig iron at the same time. Experimental results have proved that the South Arcot lignite though of a non coking variety, has good reactive properties which make it a suitable fuel for electric furnaces. It is also stated suitable shaped metallurgical coke can be manufactured from S. Arcot lignite.

The carbonised (iron and coal) briquetted coke can directly be charged into conventional blast furnaces for the smelting of iron contained in the briquettes. This may not be economic because additional charges of

metallurgical coke may be necessary. Besides better results can be obtained by subjecting these composite briquettes to complete gasification in a "Liquid Slag and Gas Producer" or better still in a suitable "Water Jacketed Low Shaft Furnace". Other ingredients such as lime stone etc., can be charged into the liquid slag producer or low shaft furnace to complete the reduction of the ore into pig iron. In any of the processes if oxygen or air enriched with oxygen is introduced into the producer, instead of pure air, a producer gas of uniform composition and fairly high calorific value can be obtained.

COMPOSITION OF LIQUID GAS.

	obtained from low temperature carbonisation of S. Arcot lignite at 600°c. South Arcot.	from low temperature carbonisation of German lignite. Germany.
Oxygen	2. 0	—
CO_2	24. 2	8. 0
Unsaturated Hydro carbons	4. 6	2. 5
Carbon monoxide	20. 8	20. 0
Methane	36. 3	45. 0
Hydrogen	8. 2	15. 0
Nitrogen (Diff)	3. 9	2. 5
H_2S by volume	2. 76 per cent	—
Gross calorific value	Calories	3800
	B Th U	432

During such gasification of the carbonised composite briquettes, the iron in the briquettes is completely reduced and melted. The process does not require the addition of any metallurgical coke. Should the amount of carbon contained in the briquette be insufficient for the charge or should there be an excess of carbon in the charge then either shaped metallurgical coke (made from either semi coke or lignite) or lumpy iron ore as the case may be, can be added to the charge to produce the desired quality of pig iron.

The advantages of metallurgical carbonisation processes are the combinations of three different processes, viz. 1. low temperature carbonisation. 2. metallurgical smelting of soft and powdery iron and 3. generation of water gas for synthesis. The capital cost of the plant installation can be considerably cut down.

Large quantities of town gas of fairly high calorific value generated in the process besides being used for synthesis of light oils and lubricants, can be piped economically for industrial and domestic uses.

As for the economy it is reported from Germany that Lorrain Minette (a fine grained iron ore) with a low iron content of 35% when subjected to metallurgical carbonisation process yields about 30 to 35 tons of pig iron and 1 ton of primary tar besides other liquid products suitable for synthesis, which estimate is without the use of any metallurgical coke.

By the conventional method of iron smelting the production of 1 ton of pig iron would require about 1.3

tons of metallurgical coke which again requires about 1.8 tons of coking coal for its manufacture.

The following are the established methods by which soft powdery and low grade ore can be smelted without the use of metallurgical hard coke.

(1) *Swedish Weiburg Process*

The process is mainly dependent on cheap electricity. To get at such low charges of electricity the iron works should have a source of cheap supply of electricity. For economic considerations installation of the works near about the lignite mines should prove advantageous. Though the process works on charcoal, lignite possesses good reactive properties according to Norweign authorities and should be suitable for electric furnace. It should be possible to smelt the pulverised iron ore recovered by magnetic seperation by this or other processes in which electric energy replaces fuel for smelting. Only a small quantity of carbon is necessary in this case to reduce the iron oxide into metal. This can be met by lignite.

(2) *Krupp Renn Process*

The next process, Krupp Renn process is suitable for conversion of low grade ore and even lateritic iron ore as mined without benefication. In this, the reduction of iron ore is effected directly in a rotary furnace heated either by a producer gas or pulverised fuel. The ore and coal have to be introduced in a crushed condition. If Salem iron ore is to be crushed it may as well be beneficiated for efficiency of operation, as higher the percentage of iron ore in the charge, better will be the out turn. Lignite can be utilised to generate producer gas. It

would be better to use lignite in the pulverised form for the purpose of reduction of the ore by pulverised fuel firing. Since no special physical properties like screen size and abrasive resistance are needed for a fuel in this process, the use of lignite as fuel should be adequate. High ash content of the fuel offers no operational difficulties. The iron in this process is obtained in compact lumpy semi solid form containing but little carbon and embedded in slag. The lumps are then crushed after cooling and again subjected to magnetic seperation. The recovery of iron in the lump amounts to over 90% depending on the ore and the mode of seperation. This is practically free from slag and is in size ranging between 1·5 to 5·0 m.m.

The pellets could be easily and cheaply converted into steel by the American Turbo Hearth process. This is a cheap and novel method of producing steel. The conventional Open Hearth requires to be fired by a fuel either oil or some form of gas. The Open Hearth requires 8 to 12 hours to "cook" a batch of charge of steel, whereas in the new Turbo Hearth process no fuel is required and the charge is cooked to steel within 12 minutes. The plant is in the form of a giant coffee perculator of steel and cooks molten pig iron into steel by blowing air, from the sides, to flow over the molten iron. It is stated that a 30 ton Turbo Hearth furnace could make atleast 60 tons of steel per hour.

The daily capacity of a Krupp Renn furnace is 100 to 200 tons iron pellets depending on the grade of ore

fed. The fuel consumption is about 30% of the ore fed. Of this about 10% is required for firing either in gaseous or in pulverised fuel form, the balance of 90% being required for adding to the charge in the furnace.

Whether fuel containing high sulphur can be used is however doubtful.

(3) *Sturzelberger Process*

The Sturzelberger Process is the only small scale operational method which has successfully established itself in Germany as a manufacturing process for making of liquid pig iron without the use of metallurgical coke. Compared with the Krupp Renn method the main difference lies in the preparation at higher temperatures and the recovery of iron in a liquid state.

In this process the "Trommel"—furnace which is practically a circular open hearth revolvable around its longitudinal axis measures 12 ft. in diameter and is 40 ft. high. The heating of the furnace (in which a mixture of crushed ore, limestone and coal, cokebreze of Lignite are introduced) is effected by means of pulverised fuel firing and air preheated to about 500°C. A special feature of the process is that the gases expelled at 1300°C. to 1400°C. are thoroughly utilised in calcining the limestone, drying of the coal and in preheating the ore charge.

The average capacity of a unit of this type is about 100 tons of pig iron per day and a plant of double this capacity may cost about Rs. 19 to 20 lakhs at present.

The furnace can be operated with a basic or highly basic slag depending upon the composition of the burden and the intended composition of the pig iron. *Whilst the P content of the ore is completely* carried into the pig, the sulphur content can be adjusted in a very wide range by varying the slag basicity. Even with a very high sulphur content in the burden, sulphur reduction below 0·03 per cent can be effected in normal operation. Manganese, silicon and titanium are being reduced to a far smaller extent than in shaft blast furnaces, which offer an opportunity to control the reduction of certain elements according to requirements.

The total fuel consumption is about 1350 kg. per ton of pig iron when working with a highly basic slag and 950 kg. only when the furnace is operated with a basic slag.

With high grade low phosphorous ore, the process is adaptable to produce a low sulphur pig equal in quality to the valuable Swedish charcoal pig iron.

For low temperature lignite coke with about 1·5 per cent sulphur, the process is by all means better suited than the Krupp-Renn process. Since P cannot be reduced during the operation in the Sturzelberger furnace. ore of a higher phosphorous content make the refining of pig iron into steel in open hearth or electric furnaces imperative.

(4) *Metallurgical Carbonisation Process*

In Metallurgical carbonisation process powdered bituminous coal is• thoroughly mixed wiih fine grained

iron ore and briquetted. The composite briquette is then subjected to low temperature carbonisation in either a "Liquid Slag Producer" or in a "Water—Jacketed Low Shaft Furnace". In the case of non-coking coals the briquettes would need a binder. Sulphite Lye or waste hydrocarbons have successfully been used abroad as binder for a composite briquette as above. The bituminous substance, in the coal and the binder, expelled from the briquettes during the low temperature carbonisation stage, are recovered as a primary tar which again is subjected to further distillation for recovery of various valuable bye-products like Motar Benzol etc., etc.

The briquette thus carbonised consists mainly of iron particles embedded in the coke without much tarry matter in it.

The carbonised briquettes are sufficiently strong now to be charged directly in a blast furnace and can withstand the pressure and abrasion caused in a blast furnace.

It will, however, be uneconomic to use them for such purpose, as the blast furnace can neither take advantage of the reducing properties of semi coke nor even of the partially effected reduction of the iron ore, and will require, in addition, a further charge of hard coke, to avoid the use of which, the Metallurgical coking process has been developed.

As already stated better results will attain from complete gasification of the briquettes in a "Liquid

Slag and Gas Producer" where-from a producer gas of fairly uniform composition can be obtained. The calorific value of the gas can be improved by feeding Oxygen-Enriched-Air, for combustion, instead of pure air. The gasification by this method will produce gas practically free from Nitrogen.

The metallurgical carbonisation process combined with complete gasification of the briquettes, therefore, serves three purposes viz :

1. that of yielding primary tar (from the 1st stage) for distillation.

2. Smelting of iron ore in Liquid Slag and Gas Producers or Water-Jaketed Low Shaft Furnaces and

3. production of a rich Water-Gas of high calorific value either for direct industrial use or for purposes of synthesis.

For the above reasons considerable economy in plant installation is possible in Iron and Steel Works projected on the above lines.

The above process has been experimented on with bituminous coal of a non-coking variety but it yet remains to be seen whether South Arcot Lignite will react equally well in this direction.

(5) *Conventional Blast Furnace Smelting with Shape Lignite Coke*

As can be seen from the note below, it may even be possible to adopt the conventional Blast Furnace practice for smelting of Salem Iron Ore with shaped Metallurgical coke manufactured from South Arcot Lignite.

Should the new U.S. method of concentration of Low Grade Iron Ore as stated below, prove to be successful then it would be possible to smelt Salem Iron Ore—after crushing, beneficiating and rolling it into pellets, in normal blast furnaces, with shaped Lignite coke, replacing Hard Metallurgical coke in the process.

(6) *Concentration Process for Low Grade Iron Ore*

This promises to be a commercially practicable process for extracting high-quality iron pellets from low-grade magnetic taconites in the plant operations conducted by the Erie Mining Company. As a result of these tests, the company has decided to make engineering studies for the setting up of major plants to extract the iron deposits on a commercial scale. These plants would have a capacity of 10,000,000 tons of concentrated iron annually, it is stated. It is estimated that the top-grade, direct shipping ore of the Mesabi range which supply 80% of U. S. requirements, will be sufficient to last only for another 20 or 30 years; the taconite deposits are thought to total considerably and would be sufficient to meet U.S. requirements for 50 years. The President of the Erie Mining Company said that the first large plant contemplated would be capable of producing 2,500,000 tons of concentrates annually. If this plant should be successful, a similar unit would be built, bringing the capacity to 5,000,000 tons a year. The process used by the company reduces three tons of taconite rock to one ton of walnut-size

pellets containing from 63 to 65 percent iron, it is stated. The crude taconite passes through a series of dry-crushing and wet-grinding operations which pulverise it so that the iron particles can be separated magnetically from the waste siliceous material and then the particles are rolled into pellets which are baked for strength. The pellets can then be shipped to blast furnaces. The process is thought to make production of these pellets competitive with top grade ores. The Erie Mining Company is operated by Pickands Mather & Company (Union Commerce Building, Cleveland, Ohio).

New United States Magnetic Separator

A new type of separator for extracting usable iron ore from the low-grade ore in Minnesota's Mesabi Range has also been developed by Jeffrey Manufacturing Company of Columbus, Ohio. The magnetic separation process calls for grinding the low-grade iron ore in stages and passing it through the new separator between stages to eliminate the rock. After the final grinding it is mixed with water and passed through another type of separator. The final product is dried and formed into small round lumps of nodules.

There are distinct possibilities, of converting South Arcot Lignite into a suitable metallurgical fuel, by processing it for the purpose, by the "Two-step Carbonisation Method" developed in U.S.A. and improved in Germany.

The 1st attempt in the manufacture of a shaped Coke by the "Two-stage treatment" in succession was started in U.S.A. This process called the "Carbocoal

Process" was invented in U.S.A., in their attempt to produce a hard dense smokeless burning coke, of even shape, by low temperature carbonisation by which also a large quantity of low temperature tar could be recovered. The "Carbocoal Process" however did not develop further due to technical difficulties which impaired economical working of the process.

In U. K. Stroffard and Pick developed a process to produce coherent coke from non-coking coals. This process was tried out at a Gas work and is known by the name "Fuelite" process.

Manufacture of Coke From Lignite

The manufacture of suitable blast furnace coke from Lignite or Brown coal has been attempted by several firms in Germany and particularly by Messrs Lurgi Gesellschaft fuer Waermetechnik m.b. H. Franfurt am Main and the Didier Werke (A. G. Berlin), Essen, Germany. Two different processes have been developed for producing a hard compact and coherent coke from Lignite, known as :

(1) The Lurgi-Krupp Lump Coke Process ; and

(2) The Two-Step Carbonisation Process.

Of these the two-step carbonisation process promises to be more economical.

In this process the manufacture of the coke from Lignite is accomplished in several stages. The carbonisation of the Lignite in the 1st Stage is effected in Vertical Chambers, intended for continuous operation, heated from outside. The process is known as "Uniflow

Process". The coal in this process is crushed to, 0 to 50 m.m. size and subjected to carbonisation at temperatures between 550°C to 600°C. The semi-coke is continuously discharged, cooled, crushed and briquetted with addition of tar, if necessary. The briquetted carbonised coal are then recarbonised again at temperatures of 900°C to 1000°C. The special feature of this process lies in the construction of the ovens in which the gases liberated are suitably coursed and subjected to distractive distillation. The yield and quality of byeproducts recovered by this process is in many respects superior to those obtained from High temperature carbonisation process.

The coke produced from these ovens compare favourably, as regards its physical properties, with metallurgical coke made from coking coals.

Shaped Metallurgical coke was first made from a Yugoslavian Lignite by the above process. This was tried out by use in a blast furnace which definitely established the superiority of shaped coke over the Metallurgical coke made in high temperature coke ovens.

The problem of manufacturing a suitable blast furnace fuel from *Lignites* or other geologically young non-coking coals was taken up by the Didier Werke in Germany who successfully solved the problem after experiments and large scale trials. The final test was trial run of a blast furnace, covering several days, using shaped lignite fuel for smelting iron-ore. This test established that a shaped metallurgical fuel made from Lignite was capable of with-standing the most rigorous tests in a blast furnace.

It is stated that geologically young, non-coking coals, like Brown coal, or Lignite, Xylites etc., with high tar content to meet the requirements of a briquetting plant are readily amenable to the formation of a suitable shaped metallurgical fuel by the "Two Stage Carbonisation Process."

Blast Furnace Trial with Shaped Lignite coke

A shaped coke product from lignite by the Two Stage Process as outlined in the foregoing was tried on a normal blast furnace which had a shaft length of 2.4 times the inside diameter to conform its adaptability for this purpose. The other parts of the blast furnace plant as well as the condition of the furnace itself did not offer very favourable circumstances for carrying out such a trial. Apart from the properties already mentioned before, the particular Lignite coke had the following composition.

Water	2	to	4%
Ash	18	...	20%
Fixed Carbon	97	...	93%
Volatile matter	1	...	3%
Sulphur	1.5	...	2%

The ash had the following chemical composition:

Chemical composition of Ash in Lignite Coke

Constituent.	determined as	per cent.
Silicon	SiO_2	32.60
Iron	Fe_2O_3	18.90
Alumina	Al_2O_3	14.80
Lime	CaO	15.80
Magnesia	MgO	3.96
Sulphur	SO_3	14.31
Rest	...	·37

An operation of the blast furnace covering several days and using this shaped Lignite coke conclusively proved that in spite of the high contents of ash and sulphur an excellent pig iron was made from a burden consisting of a mixture of Harematite, Bog Ore, Roast spar and Brown ore. The composition of the pig iron produced during this trial run corresponded to the following:

Composition of Pig Iron

Constituent.	Formula.	Percent.
Manganese	Mn	2.090
Phosphorous	P	0.046
Copper	Cu	0.117
Antimony	Sb	0.052
Carbon	C	2.470
Sulphur	S	0.170
Silica	Si	0.414
Iron	Fe	94.041

The coke consumption in the blast furnace in relation to 1 ton of pig iron increased in comparison to the normal coke otherwise used in direct proportion to the higher contents of ash in the Lignite coke.

From the results of this trial carried out on a commercial scale it could be deduced that shaped Lignite coke manufactured by the two stage process meets the conditions of a normal blast furnace operation in every respect.

Economy

The manufacture of a metallurgical shaped coke from South Arcot Lignite by the two stage process

should be absolutely economical particularly when the production costs are compared with metallurgical hard coke which has to be imported from distant places from the Bihar Coal Fields which would thus involve high freight charges.

In a particular case tested in Germany in which a lignite served as basic fuel and which contained so much water that it had to be subjected to predrying, the price of the lignite amounted to 8.50 R.M. per ton after its contents of water were reduced by drying to 15—16%. The costs of the shaped coke manufactured by the two stage process on a plant having an output of 300 tons of coke per day amounted under the local conditions given to 19.20 R.M. per ton of coke. In judging these costs it must be taken into account that the artificial drying of the lignite with a very high moisture content increases the manufacturing costs very heavily. With a basic fuel which in the raw state does not contain more than 15—16% water as the South Arcot Lignite does, coke could probably be manufactured at a much lower cost which will compare favourably with imported hard coke.

Effect of low Moisture content of South Arcot Lignite

A very important point to note here is that no pre-drying plant would be necessary in the case of South Arcot Lignite due to its low moisture content, as fuels containing 15 to 25% moisture can readily be carbonised, thus indicating a definite saving in plant and installation costs as well as in working cost..

It may be interesting to know that extensive pre-drying plants are a necessary adjunct to any lignite processing plant abroad due to the high moisture content which some times amounts to over 60% in foreign Lignites.

Ash contents of Lignites

Now coming to the question of Ash content of Lignites, it must be remembered that the Ash content in fuels has a great bearing on the manufacture of metallurgical coke. It would be interesting to know that the Ash in the fuel is increased from 2:2 to 2:8 times by carbonisation. For example, in carbonising a fuel containing 5% Ash the percentage of Ash in the coke may increase up to 15%. Since the Ash content of a coke has considerable effect on blast furnace operation so a coke with low ash content is always desired in blast furnace practice. The Ash content in a coke should not as a rule exceed 9%. But the maximum ash permissible in a coke is also greatly influenced by its chemical composition. For example the sulphur (depending on its mode of occurrences) contained in the coal remains the more in the Ash the more the lime the Ash contains.

Chemical composition of different kinds of Lignites and of Cokes from true coal

Origin	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O-Na_2O	S	P_2O_5
1	2	3	4	5	6	7	8	9
Rhenish Lignities:								
1. Fortune mine	1.75	40.6	10.58	35.89	10.0	1.18	...	...
2. Average	6	5	15	50	4	...	8	...
Central Germany:								
3. Werschen-Weissenfels dt.	4.97	5.8	19.05	37.1	1.99	0.83	8.3	...
4. Hofmann I mine, Helmstedt.	2.20	9.04	16.30	45.0	5.30	...	5.3	...
5. 'Alwiner Verein' Ralle	51.05	9.22	5.33	26.57	1.72	1.81	1.7	...
Cassel:								
6. Gewerkschaft Friedr. Hungen	34.09	32.3	9.04	14.26	1.84	0.57	3.1	0.14
Bohemia:								
7. Bohemian Lignite	51.2	33.91	9.15	2.64	0.48	1.01	1.0	0.04

Silesia:								
8. Lignite from Muskau	43.2	48.2	7.07	0.52	0.58	0.28	0.2	1.59
Upper Bavaria:								
9. Pitch coal Peissenberg	21.37	9.11	22.62	29.21	5.18	...	4.2	...
Jugoslavia:								
10. Shaped coke from Lignite Kreka mine	33.74	15.20	19.0	15.20	3.98	...	5.07	...
Coke from true Coal:								
11. Ruhr I	41.6	28.5	14.2	5.6	2.1	4.11	0.95	0.54
12. Ruhr II	49.9	29.4	13.4	2.3	2.3	...	0.28	1.08
13. Aix la Chapelle	42.2	28.1	14.8	3.9	2.7	5.1	0.87	0.50
14. Upper Silesia	24.4	14.6	20.1	18.2	0.7	...	3.45	0.16
15. Ostrau	37.2	25.2	13.3	10.9	4.7	2.3	1.40	2.19
16. Ruhr III	36.8	30.9	17.1	5.8	6.5	...	1.00	0.54
17. Ruhr IV	33.1	30.1	23.1	10.4	8.8	...	3.20	0.45
18. Ruhr V	35.0	26.9	14.3	9.8	3.1	...	1.92	0.62
South Arcot:								
19. S. Arcot Lignite I	21.5	13.2	27.3	26.0	6.6	1.2	4.1	...
20. do. II	14.7	22.2	8.1	30.8	7.0	6.3	9.8	...
21. do. III	19.3	15.8	32.3	25.0	2.8	...	5.2	...
22. do. IV	22.7	14.4	27.6	22.5	3.6	0.7	8.5	...

From the above experimental results submitted by Dr. B. S. Srikantan, it will be seen that South Arcot Lignite contains more of lime than Silica or Alumina.

In comparing the contents of Ash in the coke it must be remembered that smelting of Acid ores using Lignite Coke with a basic Ash, a higher content of Ash in the coke compared with usual Hard metallurgical coke is by no means a disadvantage.

The Salem Iron Ore, to be smelted, has a predominently high silica content. The sulphur content in the ore is, however, comparatively small as can be seen from a study of the analysis of the ore given below :

Analysis of Salem Iron Ore

No.		Fe.	SiO	TiO	P.	S.	MgO	CaO
I	...	50.46	23.88	2.56	0.124	Tr.	0.98	4.02
II	...	61.40	18.16	2.16	0.030	Tr.	0.36	2.12
III	...	34.44	44.30	0.14	0.037	0.065	0.36	0.12
IV	...	36.10	43.87	0.13	0.137	Tr.	0.41	1.69
V	...	38.34	39.51	0.29	0.123	Tr.	1.13	0.70
VI	...	68.27	1.15	0.60	0.031	0.013	0.03	0.10
VII	...	36.27	41.46	0.16	0.094	Tr.	0.04	0.39

In smelting ore in the presence of acid, ashes from normal coke about 1.5 to 2 times the amount of slag is produced after neutralizing with lime. By weight this will correspond to 1.75 times the addition to limestone, if not basic ores of a corresponding composition would be required. Vice Versa owing to the presence of basic lignite ashes, practically an equal weight of lime can be saved by smelting basic ores in such a case about 1.5 to 1.6 times the amount of limestone can be saved.

Contents of Sulphur

On account of the unfavourable properties which develop in pig iron due to the presence of sulphur and considering the amount of work which the blast furnace has to do in order to reduce the contents of sulphur in the pig iron to a minimum it is obvious that in the choice of the basic fuels for the manufacture of coke those with low contents of sulphur are aimed at. The sulphur in the fuel is distributed during carbonisation over the gas, tar, water and the coke and it can be taken as a rule that the contents of sulphur in the coke correspond to those of the original fuel. As far as conditions permit it should be our aim to produce a lignite coke with contents of sulphur approaching those of the normal coke i.e., about .8 to 1.2%. There is, however, the possibility of operating with a basic slag also from a charge which contains upto 40 kilos of sulphur inclusive of the sulphur contained in the lignite coke per ton of metal, to produce a pig iron with contents of sulphur not exceeding .1%. For such an operation comparatively rich ore is required so as to

limit the amount of slag produced. Otherwise, the sulphur removing process by means of soda is applied which, even if the contents of sulphur is as high as .7% will effect a considerable reduction of sulphur content of the Pig Iron.

By such an after treatment of the pig iron, with medium contents of silicon and the application of a mixture consisting of soda, lime stone and fluorspar or using soda only for reducing the contents of sulphur to .1%, in a two stage process, the following amounts of soda will be consumed.

Percent of Sulphur in Pig Iron	·7	·5	·2
Consumption of soda per ton of pig iron in kilos.	25	20	10

In the first stage the contents of sulphur are reduced to ·2 and in the second to ·1%.

The question as to how far the contents of sulphur can be reduced inside of the blast furnace and what portion is to be subjected to the after treatment in the laddle can only be determined on the composition and cost of the Iron ore, the resultant pig iron and the costs of coke, lime and soda.

The lignite deposits of South Arcot and the Iron ore deposits of Salem—Tiruchi region holds great possibilities for the industrial development and hence the economic prosperity of India with particular reference to S. India.

(With acknowledgment to Sri H. K. Ghose for the help rendered in writing this chapter).

Labour

Suitable labour in the locality is not available in plenty and when large scale operations are started, it may be necessary to import from outside. Local labour is mostly agriculturists. It may be quite possible that these men can be trained and they may pick up the work in a short time. The difficulty will be twofold, one of training the labour and the other of using the labour. For the type of opencast mining it may be necessary to have trained labour. Such labour is difficult to enlist. Perhaps Salem and Vizag, where large scale open cast mining are going on may offer some personnel. In Gorakpur and adjoining Districts of Uttar Pradesh, during war years, large numbers were trained by the Directorate of Unskilled Labour and Supply and Directorate of open cut Coal Mining. Some such training may ultimately become necessary in this area as well.

A speed in excavation would be the criterion in reducing working costs. So the maintenance of a regular labour force according to requirements is essential. In any event, suitable conditions have to be created to attract and maintain sufficient and suitable labour.

Suitable and sufficient food havc to be provided regularly for the labour, staff and officers and their families.

Suitable accomodation has to be built to house the labour, staff and officers.

Health and sanitation have to be attended to, to keep the men in condition for work; by building a

hospital and by keeping public health staff to look after sanitation, prevention of epedemics etc.

Schools have to be built for the education of adults, illiterates and children of the colony.

Suitable arrangements have to be made for the recreation of the labour by opening clubs, libraries, playgrounds and other amenity.

In compliance with the provisions of the Mining Rules creche, baths etc., have to be built.

A start from scratch has to be made. The mine fields are situated in a typical Indian village area. The village has no facilities whatsoever to contain the huge number of staff and labour. The nearby villages are equally tiny. The set up of villages and conditions obtaining may answer at best the needs of a few hundred only.

A start is made by constructing roads. Electricity and water are made available. Transport from and to nearby villages have to be arranged for. In fact, a new town with all modern amenities have to be built up.

As excavating and earth-moving machinery are to be used in the mining, it may be necessary to recruit a large number of skilled labour as well from outside.

The prevalent rates of labour in South Arcot are very reasonable and moderate. It will therefore be advantageous to recruit local labour in the first instance and get it trained in the work.

There are quite a number of unemployed in the District. There is no continuous engagement even for agriculture labourers.

The project it is hoped should solve to some extent the unemployment problem in and around the locality.

Economics of South Arcot Lignite

While considering the economics in lignite mining, ratio of overburden to lignite in the first instance is to be considered. Near about Thandavankuppam, where the pilot project is being worked, the surface level of the site is 158.09 feet and the thickness of lignite is 89¼ feet, giving a proportion of 2 : 1. There are other favourable spots with thickness of lignite varying from 70. 66. 65, 64, to 61 feet and in most of these places nearabout the site the ratio of overburden to lignite is within 3 : 1. This is quite a favourable position.

In calculating the gross resources of lignite in the prospected area, the totals of bore hole thickness was 2717 feet 5 inches in 72 bore holes, the arithmetic mean of thickness of seam being 37.75 feet. Taking the specific gravity of lignite as 1, and 36 cubic feet of lignite weighs 1 ton, the area over which lignite is proved being 75 square miles and the arithmetic mean of thickness of lignite in 72 bore holes being 37.75 feet. we get the total quantity of lignite as

$$\frac{(75 \times 5280 \times 5280) \times 37.75}{36}$$

that is 2192.52 million tons approximately. On the basis of empirical formula that is a million tons per foot of thickness of lignite per sq. mile the above would amount to 37.75×75 or 2831.25 million tons. This then is the large available quantity.

Taking the average thickness of lignite as 48 feet and lignite to measure 40 cubic feet to the ton, the approximate quantity in the area now explored south of Cuddalore—Vridachalam road, may be taken as 368 millions tons. The lignite beds thicken out and extend further to south and south east and hence a much larger quantity may be expected when further prospecting in these directions are made.

It is expected that two thirds or about 67% of the total quantity can be recovered by slicing the seam and stowing with sand in stages (where it is about 50 feet thick) leaving sufficient lignite in the roof and floor to act as barriers against the artesian horizon. Much greater extraction however is possible in Uyakondaravi and Valayamadevi region where the seam is over 80 feet.

The probable quantity in the areas explored on the north bank of river Vellar may be taken as 22.6 million tons.

It will be seen that the ratios of recoverable to nonrecoverable in the two areas (north and south of Cuddalore—Vridachalam road) are in the inverse proportion, that is while we may expect to extract only one third of the total quantity from the thicker areas of the north, we may expect a recovery of atleast double that percentage (or about 67%) from the areas explored to the south.

It will also be seen from the calculations given hereunder that while we may expect only 5.5 million tons

per sq. mile to be recovered from the thicker areas in the northern side of the Cuddalore—Vriddachalam road, about 22 million tons can be recovered from the areas explored to the south of the above road.

On the northern side

Quantity contained per sq. mile in a seam 24 feet thick is

$$\frac{5280 \times 5280 \times 24}{40} = 16{,}727{,}040 \text{ tons}$$

and quantity available from a 8 feet slice of above seam is

$$\frac{5280 \times 5280 \times 8}{40} = 5{,}575{,}680 \text{ tons}$$

On the southern side

Quantity contained per sq. mile in a seam of 48 feet thick is

$$\frac{5280 \times 5280 \times 48}{40} = 33{,}454{,}080 \text{ tons and}$$

quantity available from 4 nos 8 feet thick slice from above is

$$\frac{5280 \times 5280 \times 32}{40} = 22{,}302{,}720 \text{ tons}$$

Thus it will be seen that the quantity of lignite recoverable per sq. mile from the southern portion may be more than four times the quantity that may be expected from the northern portion.

Now having been assured of the large quantities in the respective regions, it is for us next to consider the quality. Tests carried on in the various laboratories of

the world and here in India have proved that the South Arcot lignite compares very favourably with those of other countries. The moisture content in fact is comparatively low. The published results leave us in no doubt whatsoever as to the suitability.

With the data thus obtained, two problems remain to be solved. They are ;— 1. How to mine the lignite economically and safely? and 2. How to use the lignite economically and efficiently?

Taking the first, it is necessary to mine quite a good quantity, say a million tons a year atleast. Next arrangements have to be made to consume the quantity. With regard to the first there are two ways of doing it. They are either by manual labour or by modern machinery. Tenders were called for at one time to remove the earth by manual labour, using hauling and pumping machinery available. Quite a number of tenders were received which were as varied in character as their number. The minimum was a flat rate of Rs. 120/- per unit excavated upto a depth of 180 feet. The total cost involved in this method was estimated to be Rs. 1,20,00,000. This aspect is considered for the simple reason that in the event of suitable machinery not being available for any reason whatsoever, it may be necessary to consider a contingency of this kind. There are quite a large number of personnel to do the work though they are unskilled. They may fit in ultimately with training.

If on the other hand mining is undertaken with the help of modern excavating and earth moving machinery, as it should be, not only the work will be speeded up but there is bound to be a big saving in cost. For example 12 cubic yard dragline will do the job of a thousand men in a day. The use of suitable machinery depends not only on availability but also on ability to procure it. The economy of this mining is therefore bound to depend on the capital outlay that can be found for this project.

Mining however cannot be cheap. This is not like developing any other mine. The winning of the lignite is bound to be costlier owing to the presence of pressure waters both above and below the lignite, the soft nature of the lignite, as also the soft layers of rocks above and below it.

Again the initial cost could only be made good after years of working. No calculations at present can be standard till the mine is actually worked out. But it is necessary for us to have an idea and it may not be far wrong to assume certain calculations from the available data.

Taking the mean thickness of lignite at 60 feet we shall get 1,05,60,000 cubic feet of lignite from the excavation which at 36 cubic feet per ton would weigh 2,93,383 tons. The probable revenue from the china and alumina clays may be Rs. 35,54,910. The probable cost of taking lignite at Rs. 80/- per thousand cubic feet would be Rs. 87,28,000. minus Rs. 35,54,990 or Rs. 50,73,010,

giving the price of lignite per ton as Rs. 17/4. If the excavation charges are assumed to be Rs. 60/- per 1000 cubic feet, the approximate cost per ton of lignite should be Rs. 10/- These figures are given just to give a rough idea as to the trend the cost may take, when the mine is fully developed and if the estimated amount of materials of economic value is obtained. There are several factors which may however affect the best of calculations and estimate.

For the present, we have to be content with the sound maxim that the economics of this industrial product is bound to depend on demand and supply. If the demand turns out to be urgent and vital, the price becomes no consideration. The need for the product is so great, that our industrialists are prepared and willing to pay high prices, if only regularity in supplies, could be assured to them.

Here it may not be out of place to consider the pit-head prices of coal in India. Bengal and Bihar selected A grade from dust coal and slack cost Rs. 15/12, and Madhya Pradesh Coal Rs. 17/8. In Madras railborne coal costs about Rs. 35 to 37 whereas sea-cum-rail borne costs about Rs. 55/- per ton. By the time this sea-cum-rail borne coal reaches the interior parts, the prices go up high reaching sometimes even Rs. 75 a ton.

A product without which large scale industry is not possible is a necessity. Coal is such a product. For example, Brazil and Argentina purchase coal from the U. K. at a high cost. Due to shortage the U. K. is

purchasing coal from India. Pakistan purchases her coal at prices ranging from Rs. 75 to 82 a ton.

It is sometimes asked, "When we have such large supplies of coal available in the north, why should the south produce its coal involving heavy outlay and more so if the price is not going to be comparatively suitable?". The simple answer is that in the first place we have no justification to assume the production costs of coal in the south will be high. Secondly assuming that the prices really turn out to be high, even then there is a very good case for the south to produce its own coal. The south cannot get all its coal requirements from the north owing to transport limitations. It may take another 25 to 30 years for our railways to develop to the extent necessary to carry our present needs. During this period we cannot be suffering from short supply and by that period our requirements might grow, the problem remaining just the same for us. The railways and ports are already congested in traffic. They have to be relieved from coal handling, with a view to attending to other equally important nation-building activities India may consider export as well and the more the production the better it is. In considering the economics, these are the hidden factors to be taken into account.

Next we go to the most important part of using lignite economically and efficiently. On this depends all the economics of the problem. Owing to its very nature and condition lignite cannot be hauled over long distances or used as it is. Use of lignite in industrial

boilers is the only way. The installation of a large power station near the mines is necessary in taking the lignite. Owing to the development of Hydrel power, the consumption in the south is comparatively higher. Inspite of it one of the largest power stations viz 200 Mg is under contemplation. Again lignite may be processed. Many are the by-products looked forward to, the developement of all or any one of which in industry should cut down the cost of production of lignite. The scheme will prove a multi-purpose one. The water released will help irrigation yielding a good return. The ceramic clays when used may bring a return.

The amount to be expended on the pilot project cannot form the basis for calculating the price of lignite. When the economics of hydrel power is considered the cost of the dam is not taken into account, though there can be no power without the dam. When generation of thermal power in South Arcot by using lignite is taken into consideration, many are the doubts entertained about the economics of the project.

Lignite mining, if and when accomplished, is certain to be economical and beneficial from many points of view as many are the indirect advantages that should be derived in addition. The State is fuel-starved and the only answer is lignite production and not coal importation. On the successful working of the lignite the future prosperity of the State depends.

(Courtesy — "The Hindu")

Contributed

A new industry, and a new future for India is being dug out of the earth in South Arcot. As no where else in India, lignite, a soft brown coal of great industrial value, has been discovered, and it is believed that it stretches over an area of approximately 100 sq. miles with a layer of 80 feet thick. This rich deposit lies 170 feet beneath the earth's surface. It is there waiting to be dug, and to be used for the benefit of all-India. The deposits even if unearthed at the rate of one million tons a year will last 2000 years.

The story of the discovery that can bring new prosperity to India dates back to 1937 when a villager digging for water found instead a strange brown substance. A Chemical laboratory in Madras observed that when the substance dried it was like coal.

Fuel shortage during World War II impelled the Geological Survey of India to pursue investigations which disclosed lignite bearing area measuring 23 square miles. In 1947, the Madras Government became interested in the project and employed the services of Mr. H- K. Ghose to carry on further investigations. Under his supervision three shafts were dug into the earth and in one of them lignite was found. During excavations in 1952, a study was made by a U.S. mining expert as a result of which Mr. Paul R. Eyrich of the U.S. Bureau of Mines, under the U. S. Point Four programme, joined the present Committee of experts to prepare a quarry scheme. A pilot project has been launched and an experimental quarry of 550 feet square is being dug to recover 1600 tons of lignite to be made available for test purposes, and for consumption in plants having

facilities for burning raw lignite. The actual excavation is an easy job suitable for shovels, dumpers and scrapers. It is normally necessary to keep the exposed face of lignite constantly wet, and therefore water resources are most valuable. At first at Neiveli, it was feared, that there would be an excess of water, which would have meant, at the best employing a very expensive method of removing the overburden, probably based on German methods of using large dredges. This problem of excess water has now been met, so that it appears possible as is being done in the dry areas of the lignite workings in Victoria, Australia, to use a team of EUCLID Loaders and Bottom Dumps. Thus it has been found possible to keep the cost of removing overburden down wel- below costs involved in using other means of excavation.

Under the Indo—U.S. Technical Co-operation Prol gramme for 1952-53, an agreement was signed to provide equipment and supplies to augment the existing facilities for lignite excavation and with the co-operation of Australian Government, E.C.A.F.E. sent a team of 20 experts including among them Mr. Ghose, to study in detail the Australian methods of mining lignite.

The significance of the new found lignite deposits in South Arcot is obvious. The industrial future of South India, has almost over night acquired a vast potentiality, the outline of which alone can be seen. It will take another two to three years to place the entire operation on an organised commercial basis but the treasure is there, in such proportions as to ensure a large material benefit to the whole of India.

POSSIBLE METHODS OF UTILISATION OF SOUTH ARCOT LIGNITE

LIGNITE

- Used raw (as mined) for Generation of Electric power, Brick burning.
- Possible use in Gas Turbines.
- Used as a pulverised Fuel-Mill firing-boilers, Cement Factories, Glass factories Nitrate Industry etc.
- Used for extraction of petrol by direct Hydrogenation.
- Used Briquetted for domestic and Industrial purpose

May be used for manufacture of coal plastics.

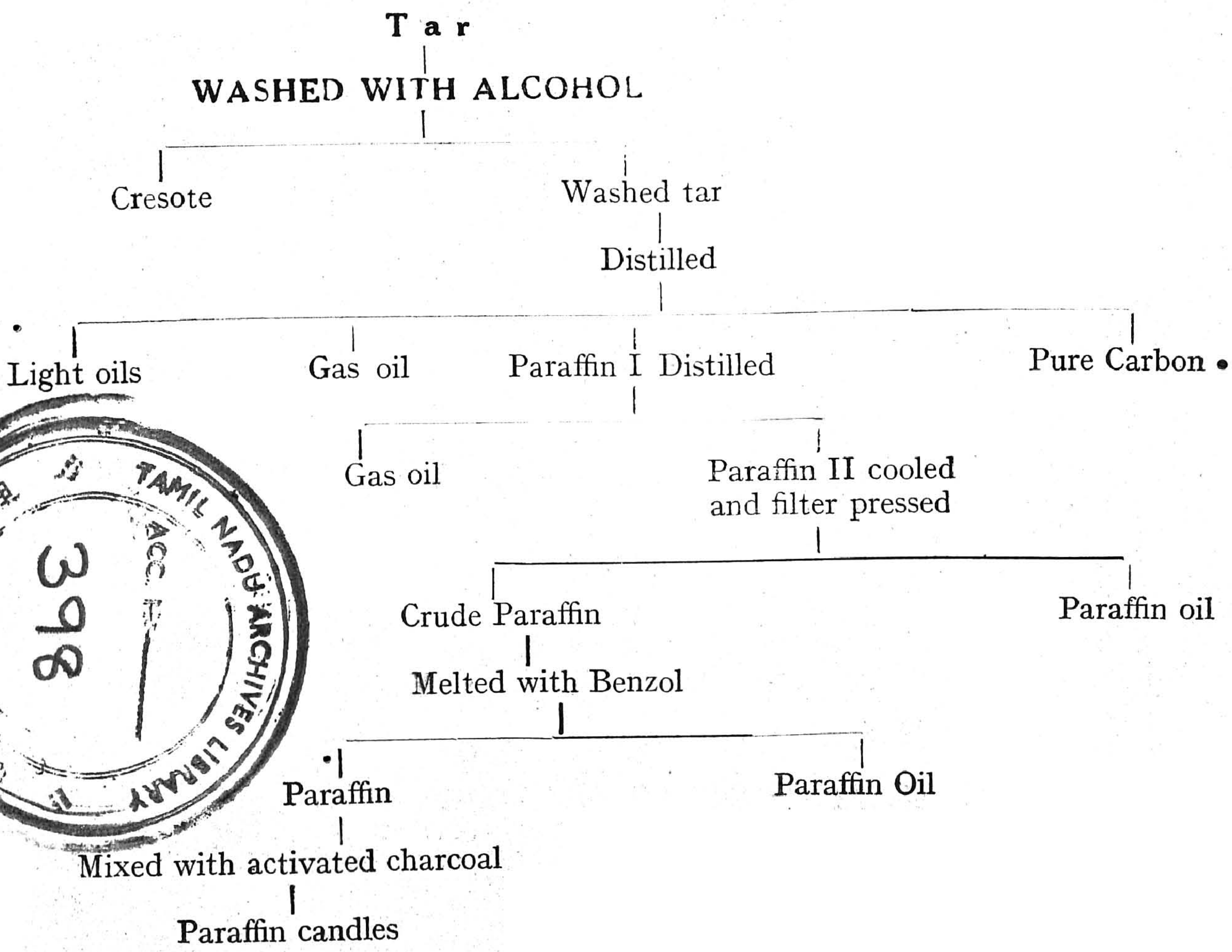
Rejections and dust may be used as a soil improver.

Subjected to Low temp. (550°C to 600°C)

or

Medium temp. (750°C) Carbonisation.

- Crude tar
  - Hydrogenation for motor Benzol
  - Benzene (Recovered by Paraffin)
- Incondensible Gas (to heat retorts.)
- Light gas for (Household or Industrial use) after briquetting
- Water



TAMIL NADU ARCHIVES LIBRARY
ACC. 398

ANNOUNCEMENT

We undertake construction of Irrigation Projects, Buildings, Roads, Bridges, etc., of any magnitude for Government Departments and also construction of Residential Buildings for individuals and societies.

Good Workmanship - Best Materials - Minimum Time
Efficient Supervision

By Trained and Qualified Engineers

South India Corporation (Madras) Ltd.,

Post Box No. 113,

NO. 2, ARMENIAN STREET,
MADRAS-1.

Castrol

In Lignite Mining
as in Coal
and other forms of
Mining
there is a

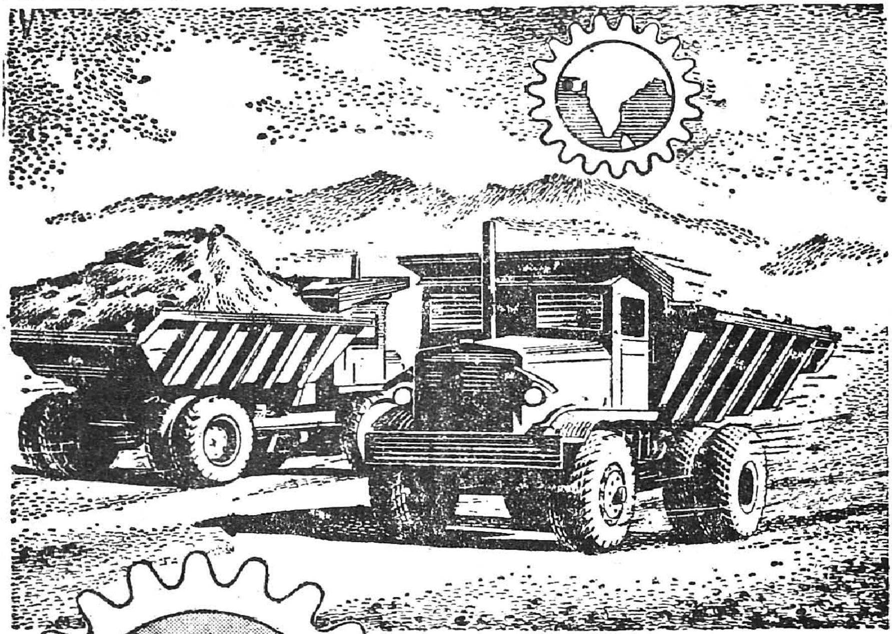
WAKEFIELD LUBRICANT

for

EVERY
PURPOSE

WAKEFIELD INDUSTRIAL LUBRICANTS

C. C. WAKEFIELD & CO., LIMITED
(Incorporated in England)
Head Office: Bombay
Branches at: Calcutta, Madras, Delhi, Cochin, Secunderabad, Lucknow and Tezpur.



EUCLID IN INDUSTRY

Illustrated are Euclid 15 Ton Rear Dumps. Many of these models are operating in Manganese Ore Mines—South Tirodi; Limestone Quarries of A.C.C.; Iron Ore Mines—Goa; Lignite Project, Neyvelli.

INDUSTRIAL projects, mines and quarries in India and throughout the world have specified Euclid earthmoving equipment because of its widely recognised reputation for reliability—hours of trouble free working are daily adding to this reputation. This has not come about by chance, for all Euclid Equipment is planned for extra strength, durability and economy.

Euclids are produced by an organisation which has specialised in the manufacture of heavy duty earthmoving machinery for years; they are specially designed to take shock loads of many tons, to be driven for long periods non-stop and to function perfectly for contract after contract with the *minimum* of attention. Euclids are the world's most proven earthmoving machines.

Write or call for full information to:

BLACKWOOD HODGE

BLACKWOOD HODGE (INDIA) LTD.

CALCUTTA • MADRAS • DELHI • BOMBAY

ASSOCIATED COMPANIES, BRANCHES, WORKS AND AGENCIES THROUGHOUT THE WORLD

84/IA

Shafts are a bore!

In deep wells, shafts are a nuisance, because they don't like bending. To keep bearings in line takes a lot of room—to say nothing of maintenance—and the bore must be dead straight. It comes expensive.. But that's the old way! A Sumo Submersible (pump and motor as one) goes down the bore-hole on the end of the delivery main, drawing A.C. power through a rubber cable which doesn't care whether it bends or not. No pumphouse needed ....No surface machinery....No trouble or needless expense with a Sumo (regd.) Submersible pump. Output?..anything between 200 and 1,00.000 g.p.h., Maintenance?..pull the pump up for a check every three years or so. Running costs?....low.

have a word with

BINNY & CO., (MADRAS) LTD.,
Engineering Dept. Madras

Agents in South India for:

Sumo **SUBMERSIBLE PUMPS**

POWER TOOLS & APPLIANCES COMPANY

Head Office: 2, DALHOUSIE SQUARE, EAST,

CALCUTTA.

Importers & Stockists of

★ GENERAL PURPOSE WORKSHOP MACHINERY

★ AUTOMOBILE RECONDITIONING EQUIPMENT

★ SERVICE STATION EQUIPMENT

★ PORTABLE PNEUMATIC & ELECTRIC TOOLS

★ "WARSOP" PETROL ENGINE DRIVEN PORTABLE ROCK DRILL BREAKERS

★ ELECTRIC MOTORS, SHEET METAL MACHINERY

★ ARC WELDERS, SPOT & BUTT WELDERS

Etc. Etc. Etc.

TAMIL NADU ARCHIVES LIBRARY
ACC. No. 398
EGMORE, MADRAS-600 0

Branches at

327, Thambu Chetty St., **MADRAS-1.**

Kashmere Gate, **DELHI**

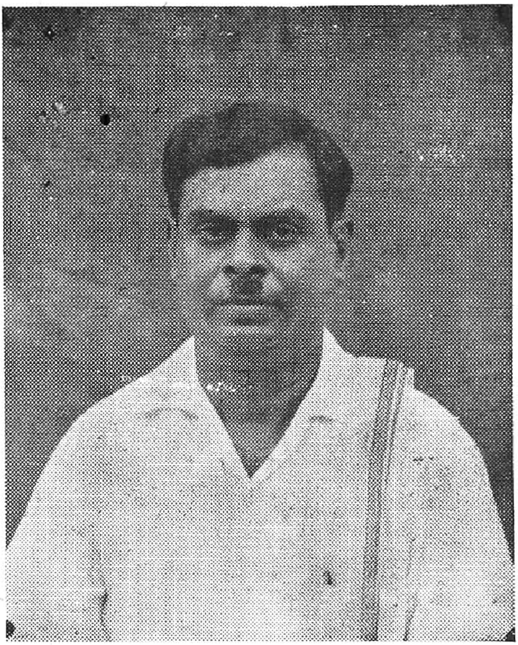
Avantikabai Gokhale St., **BOMBAY-7.**

Post Box 357, **KANPUR**

Gram : WELCOME

★

Phone
63 OFFICE
63-A RES.



AT THE SERVICE OF THE MINE STAFF & THE PUBLIC!

OUR MONEMAGALAI FLOUR & RICE / INDHIRA FLOUR & RICE MILLS

GRIND CLEAN

PADDY - OILCAKE - CHILLIES - FLOUR - Etc.

AT COMPETITIVE RATES

BUY AT BEST PRICES BEST QUALITY

RICE - THOOR DHOLL - COFFEE SEEDS & OTHER PROVISIONS

FROM

Cuddalore O. T. Cooperative Stores Ltd

President

V. K. SHANMUGASUNDARA NADAR

General Merchant

Proprietor : MONEMAGALAI FLOUR & RICE MILLS
NETHAJI DHOLL FACTORY
INDHIRA FLOUR & RICE MILLS

CUDDALORE O. T.

ASK

JACKS

ABOUT IT

LETOURNEAU — WESTINGHOUSE CO.

TRACTOR DRAWN
SCRAPERS
MOTORISED
SCRAPERS
REAR & BOTTOM
DUMPERS
TOURNA DOZERS WITH BULLDOZER
OR ANGLEDOZER BLADE
POWER—CONTROL UNITS

OLIVER
TRACTORS

CRAWLER TRACTORS
WHEELED TRACTORS
HEAVY DUTY DISC
PLOUGHS
HEAVY DUTY
MOULD BOARD PLOUGHS
POTATO DIGGERS
DISC HARROWS

IMMEDIATE DELIVERY

WILLIAM JACKS & CO., LTD.,
NATIONAL BANK OF INDIA BUILDINGS,
FIRST LINE BEACH, MADRAS-1

Phone: 3226—55129   Gram: "LIMPET"

Bangalore Office:

Shaukat Buildings, Silver Jubilee Park Road, Bangalore-2

C